CLEW - a cooperative learning environment for the Web

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PUC-RioInf.MCC06/98 March, 1998

Abstract: This paper outlines CLEW a collaborative learning environment for the Web. The project combines MUD, workflow, VRML and educational concepts like Constructivism in a learning environment, where students actively participate in the learning process. The MUD shapes the environment structure. The workflow system allows the execution and coordination of the course activities. The VRML establishes the presentation format of the courses' virtual worlds. Finally, the educational concepts influence the way the didactic material is published.

Keywords: Cooperative learning, distance education, groupware, virtual environments.

Resumo: Este trabalho descreve um ambiente aprendizado cooperativo denominado CLEW, que combina teorias educacionais, MUD, workflow e realidade virtual para o estabelecimento de um ambiente onde os alunos participem ativamente do processo de aprendizado, buscando a construção de seu conhecimento.

Palavras-chave: Aprendizado Cooperativo; educação a distância, ambientes virtuais de aprendizado.

1. Introduction

CLEW (the thread used by Theseus as a guide out of the Labyrinth) combines the presentational format of the VRML with the MUD's interaction style and the coordination mechanism associated to workflow management systems. The objective of CLEW is to create a cooperative platform of structured courses. Constructivism, learning metaphors and immersion shape the educational basis of the project.

The structure of CLEW follows the main aspects of a MUD, which is to divide the environment into regions. A MUD is an environment based on the interaction between its participants, providing access to a shared database of rooms, other objects and exits [Pavel and Nichols, 1993], thus creating a kind of virtual world [Busey, 1995]. Virtual worlds supporting multiple users give rise to a virtual community [Hughes and Moshell, 1997] which can provide the settings for productive, remote cooperative work [Rheingold, 1994].

The interactive aspects of a MUD allow the creation of a powerful collaborative environment; however, it lacks coordination. CLEW uses the characteristics of workflow to provide a way of coordinating this loose environment. As defined in [Casati, Ceri, Pernici and Pozzi, 1995], a workflow is a set of activities evolving the coordinated execution of multiple tasks. A workflow management system (WFMS) is a system that completely defines, manages and executes workflow [Hollingsworth, 1995]. The CLEW environment uses the presentation format of the VRML, allowing its users to navigate through a graphical virtual world. So the users can construct their knowledge by actively interacting with the graphical environment objects.

1.1 Related Work

Some other systems bear similarities to CLEW. The coMentor [Gibbs and Henry, 1996] is a multi-user learning environment for part-time students on theoretical social science or humanities modules, developed at Hudersfield University. The coMentor is a visual MUD on the WWW, structured in rooms. Besides these rooms, a student can access information repositories that contain previous discussion data. The coMentor does not have mechanisms to support the generation of courses and student evaluations.

Another MUD environment on the Web is the Athena - Virtual Online University (VOU) [Duckett et al., 1995]. In VOU, participants can interact simultaneously, carrying out discussions, mediated by instructors, about the study topics. Again, mechanisms to support the generation of courses and student evaluations are not provided.

ExploreNet [Hughes and Moshell, 1997] is a graphic environment used to create virtual worlds in which learners and mentors can interact. Players interact in a virtual world via their animated alter egos, called "avatars". ExploreNet uses the concepts of immersion to elaborate a course.

1.2 Outline

The paper is organized as follows. The next section discusses the educational background that guides the environment. Section 3 presents the main elements that compose CLEW. Section 4 describes the system architecture. Section 5 comments on the environment structure, describing learner participation and the services available. The last section concludes this work.

2. Educational Background

The educational theory used in CLEW is Constructivism [Bruner, Goodnow and Austin, 1956]. Through this approach, the learning process becomes more effective since the knowledge is actively built [Sherman, 1991]. In constructivism control of the learning process is shifted to the students, [Henderson, 1986; Garner, 1992]. As stated in [Salomon, 1992], the computer has an important role in the transformation of the learning process from a simple assimilation [Piaget, 1950] to an active process.

Immersion and learning metaphors complement the constructivist ideas used in CLEW. Learners needed to be engaged deeply enough to feel they are part of the environment both physically and psychologically [Low, Venkataraman and Srivatsan, 1994; Laurel, 1991]. As stated in [Wynn, 1996], situated cognition gives learning a context similar to that of the real world, providing authenticity to learning. This makes learning an exciting task. Taking advantage of the motivation induced by immersion, learning metaphors shape the semantics of learning subjects, suggesting a comparison between the system characteristics and the experiences of the real world. As stressed in [Davis and Bell, 1995], it is important to create learning models that get close to the students' reality, so that they can better assimilate a new concept.

3. The Environment Components

3.1 Participant

A participant is a player in the environment who is identified by a name and his avatar. An avatar is the element that represents a user in a virtual world. Avatars communicate with each other to engage in cooperative missions. Each mission has a pedagogical semantics specially designed to present a specific learning material. A participant also has a memory that is able to store the information he considers relevant. This memory could be shared with other participants, allowing the creation of a group memory.

The participants are categorized in types. Each type defines how a participant interacts with the environment, assigning him functions and privileges. The learner uses the environment as a consumer, participating in courses. The administrator manages the environment, accomplishing the activities related to the course, region and object supervision and maintenance. Professors are responsible for the didactic part of a course. Since a professor has several specific tasks, this type is subdivided into:

a. designer: he designs the course structure through the specification of its workflow. He is able to create, modify and remove regions and objects from the environment, allowing the adaptation of these elements to the course needs;

b. author: he is able to elaborate and insert the didactic contents of a course, which was previously structured by a designer;

c. evaluator: he works on the questions, tests and challenges that evaluate a learner during a course;

d. instructor. An instructor directly interacts with the learners during a course, helping with the participants' doubts.

3.2 Region

A region is an area without a severe border that groups participants and objects. The creation of regions may follow a learning metaphor to provide the participants' engagement with the learning activities. For example, in a course intended to teach the basic mechanisms of chained lists, a region could be configured to give the idea that a participant is travelling through the cells of a list.

These regions offer a structured way of expansion. Each new region is connected to the others, increasing the environment dimensions and its richness of metaphors. VRML files are used to generate the regions' 3D interface. The environment provides a main region where a participant has access to information regarding courses and enrollment procedures.

A region contains different objects and metaphors depending upon the course in which it is being used. Vision of a region is a set of properties that define its semantics in a specific situation. The creation of several visions of a region allows the designers to reuse the same set of regions.

A vision of a region has a memory. This memory lets the participant leave some information telling the other participants about his experiences in this region. This facility assists the collaboration between the participants and may stimulate the interest of each one in exploring the environment. This approach does not force the cooperation, letting the participant choose if he wants to cooperate or not.

3.3 Object

Interaction between participants and the environment is carried out through the objects. The objects are elements similar to those found in the real world; however, in CLEW, these objects have specific properties to provide didactic information. The objects are created using VRML files. There are two types of objects in the environment: local and shared objects.

Local objects are instantiated for each participant's interface. If a participant acts on a local object, the other participants in the same region cannot see the result of his action. If this object were shared, all the other participants would be aware of its changes. The shared objects have one instance for all the course participant interfaces.

Like the regions, objects can also have different semantics according to the course they are in. For example, a Greek geographical map could represent a map of present day Greece or of Ancient Greece. Visions of the same object increase the flexibility of CLEW, allowing its reuse in different courses.

4. System Architecture

The architecture consists of six layers: the presentation layer, the application layer, the management and control layer, the adaptation layer, the external services layer and the data layer [Fig. 1].

The Presentation Layer comprises the interface modules customized for each existing participant type. It groups the available services according to the participant's function.

The Application Layer includes the modules concerned with the creation and maintenance of the courses and with the administrative tasks. This layer provides the functions that the participants use to create objets and regions and to perform the course maintenance.

The Management and Control Layer groups the environment servers. These servers control all the functions related to the environment simulations.

The Adaptation Layer consists of the communication interfaces between the environment and all the external services.

The External Services Layer embraces the tools that the environment uses to control the sequence of the course's activities and to create and correct the students' assessment.

The databases needed to uphold the environment structure, supporting the use and integration of the available services constitute the Data Layer. This layer also comprises the VRML files that presents the environment objects and regions of CLEW.

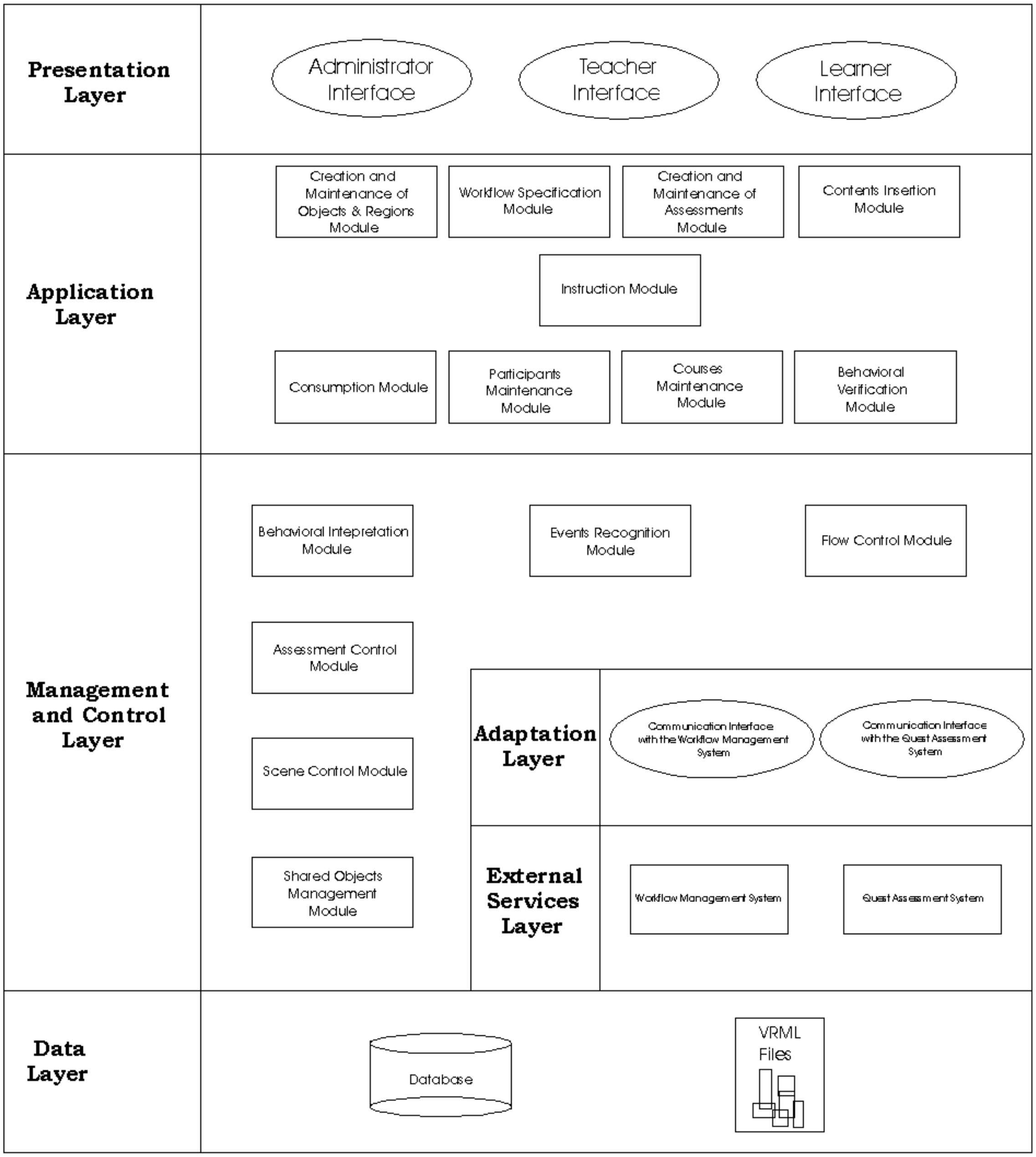

Figure 1: The System's Architecture

5. Course Development

The regions and integration between the participants and the objects that are inside them define the activities that will be carried out in a course. These activities compose a workflow that should be enacted by a participant.

5.1 Structuring a Course

The first task in a course elaboration is to create the regions and objects it uses. This can be done by a modeling tool provided by the environment. The second step is the definition of the course workflow process. This includes information about its starting and completion conditions, constituent activities and rules for navigating between them.

The starting conditions of a course are usually related to administrative information such as enrollment or attendance to a pre-requisite course. The completion ones depend upon the participant performance computed by the indexes previously described.

The activities and the rules for navigating between them make the instructional sequence of a course. To define an activity means to build part of the virtual world since an activity happens in one or more regions. The designer may use a learning metaphor and create or reuse regions, inserting or configuring the necessary objects. An activity consists of three parts: the pre-activity conditions, the actions and the post-activity conditions. The pre-activity conditions indicate a set of attributes a participant must have to be able to start the activity. The pre-activity conditions of the first activity form the starting conditions of a course. The actions define the interaction rules between a participant and the elements of a virtual world; that is, they define the tasks to be performed. Some examples of actions would be to catch an object, to talk to another participant, to answer a question posed by an active object, etc. The post-activity conditions consist of a set of attributes a participant shall obtain after he completes the actions of the activity. The post-activity conditions of the last activity are the completion conditions of the process, pointing the end of a course.

5.2 The Participant's Perspective

A course appears to a participant as a journey in a virtual world specially built to learn about a subject. To construct their knowledge, participants should complete the tasks described in the course activities. Those activities should convey engagement as a challenge or a game, to catch the learners' attention.

Let us see an example of a course on data structure. One activity would be to learn search algorithms in sequential lists. An audio tape could be used as a metaphor to represent a sequential list. There could be an active object that would ask a participant or a group of participants to look for some specific song in the tape. In order to "win the game", the participants would have to learn the search algorithms.

Another important aspect of a course is the evaluations. The evaluations should be elaborated to keep the motion of the play; thus they can not only be simple tests as a final exam. It is interesting that evaluations indicate the progress of participants as does the score of a player in a game. To offer this way of evaluating, some defiance questions may appear during the completion of the tasks, looking like obstacles in a game. This "show me what you know as you go" approach [Wiggins, 1997] provides more didactic resources to professors, and is more stimulating than only using more conventional examinations which can sometimes be boring.

6. Conclusion

The creation of learning environments that renders learning more active is initiating new challenges for research on learning [Barfurth, 1995]. The first prototype of the proposed environment is now under construction and clearly, it will need further development to be able to become a really useful learning framework.

Although the environment is still at an early stage, some other aspects may be considered such as: free navigation, to provide a way for a participant to use the environment without being enrolled in a course; co-authoring tools, to help the different types of professor coordinate their activities while constructing a course; and distributed VRML objects, to allow the insertion of objects at run-time in a region scene.

7. References

[Barfurth 1995] Barfurth, M. A. (1995). Understanding the Collaborative Learning Process in a Technology Rich Environment: The Case of Children's Disagreements. In Schnase, L. & Cunnius, E. L. (Ed.), Proceedings of CSCL95: Computer Support for Collaborative Learning (pp. 8-13). Mahwah, NJ: Lawrence Erlbaum.

[Bruner, Goodnow and Austin, 1956] Bruner, J., Goodnow, J., & Austin, A. (1956). A study of thinking. New York: Wiley.

[Busey 1995] Busey, A. (1995). Secrets of the MUD wizards. Indiana: Sams.net.

[Casati, Ceri, Pernici and Pozzi, 1995] Casati, F., Ceri, S., Pernici, B., & Pozzi, G. (1995). Conceptual Modeling of Workflows. Proceedings of the 14th Object-Oriented and Entity-Relationship Approach (pp. 341-354).

[Davis and Bell, 1995] Davis, E. A. & Bell, P. (1995). The Knowledge Integration Environment: Using the Net to Foster a Critical Eye in Science. ITP Newsletter at the University of California at Berkeley.

[Duckett et al., 1995] Duckett, G., Painter, W., Gay, M., Gerson, D., Moore, T. L., & Wallet, K. B. (1995). Athena University - VOU and GENII: A Model of Conceptual Change and Collaboration. In Schnase, L. & Cunnius, E. L. (Ed.), Proceedings of CSCL95: Computer Support for Collaborative Learning. Mahwah, NJ: Lawrence Erlbaum.

[Garner, 1992] Garner, R. (1992). Self-directed learning, strategy shifts, and shared expertise: Reactions to Palincsar and Klenk. Journal of Learning Disabilities, 25(4), 226-229.

[Gibbs and Henry, 1996] Gibbs, G. & Henry, M. (1996). A visual MUD system on the WWW: Computer supported co-operative learning for part-time students on theoretical social science or humanities modules. Poster presented at Collaborative Virtual Environments (CVE) '96.

[Henderson, 1986] Henderson, R. W. (1986). Self-directed learning: Implications for the design of instructional media. Contemporary Educational Psychology, 11, 405-427.

[Hollingsworth , 1995] Hollingsworth, D. (1995). Workflow Management Coalition - The Workflow Reference Model. In Workflow strategies (pp. 315-367). Foster City, CA: IDG Books Worldwide.

[Hughes and Moshell, 1997] Hughes, C. E. & Moshell, J.M. (1997). Shared virtual worlds for education: the ExploreNet Experiment. Multimedia Systems, 5, 145-154.

[Laurel, 1991] Laurel, B. (1991). Computers as Theatre. Reading, Mas: Addison Wesley Publishing Company.

[Low, Venkataraman and Srivatsan, 1994] Low, M., Venkataraman, S., & Srivatsan, V. (1994). Developing an entrepreneurship game for teaching and research. Simulation & Gaming, 25(3), 383-401.

[Pavel and Nichols, 1993] Pavel, C. & Nichols, D. A. (1993). MUDs Grow UP: Social Virtual Reality in the Real World. Presented at the Third International Conference on Cyberspace in Austin, Texas on May 15th, 1993.

[Piaget, 1950] Piaget, J. (1950). The psychology of intelligence. London: Routledge and Keegan Paul.

[Rheingold, 1993] Rheingold, H. (1993). Virtual communities. New York: Summit Books.

[Salomon, 1992] Salomon, G. (1992). What does the Design of Effective CSCL Require and How do We Study Its Effects?. SIGCUE Outlook, 21(3), 62-68.

[Sherman, 1991] Sherman, L. W. (1991). Cooperative Learning in Post Secondary Education: Implications from Social Psychology for Active Learning Experiences. A Paper Presentation for the Annual Meetings of the American Educational Research Association, Chicago, IL, 3-7.

[Wiggins, 1997] Wiggins, G. (1997). Show What You Know As You Go. In Learn & Live Book Resources (pp.42-45) George Lucas Educational Foundatio <http://glef.org>.

[Wynn, 1996] Wynn, S. (1996). Interactive Multimedia: Ensuring Motivation of the Learner. Working Papers Discussion Forum. Edith Cowan University, Perth, WA.

Acknowledgments

This work has been partially supported by grants of CAPES/Brazil and CNPq/Brazil, under processes 352820/96-9 and 139850/96-1. We thank our project participants, specially professor Carlos José Pereira de Lucena.