An Approach to Online Collaborative Learning using AHyCo LMS

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Abstract—**This paper presents the learning management system AHyCo with the emphasis on its group work oriented interactive modules. Our approach to collaborative learning is described, particularly adaptive group formation, asynchronous communication using forum, using files upload subsystem and group grading and evaluation.**

Keywords: online collaborative learning, computer mediated communication, forum, group forming, adaptive hypermedia, LMS

I. ONLINE LEARNING AND COLLABORATIVE WORK

Online learning could be defined as a learning environment that relies on the Internet/WWW as the primary delivery mode of communication and presentation. The students acquire knowledge via the Internet, without the need to be physically present within the learning environment [9].

Despite of the many advantages introduced by online education, one of the major problems is high students' drop out rate. According to [11], up to 35% of enrolled students drop out of distance learning classes. One of the reasons this is the lack of social interaction. Many online courses encourage interaction between students and content (e.g. by using hypermedia and online tests) and some interaction between students and a tutor (e.g. via e-mail), but little or no interaction between students. This is the main reason why the role of computer-mediated communication CMC in online learning systems should be emphasized [4, 13, 16].

In order to reduce online students' drop out rate the online learning must focus both on quality online materials and on the learning process or well prepared tutors leading the course [15], [14]. Quality design of an online course is not a simple conversion of an equivalent face-to-face course in a way that it provides students with access to online information and tests [9, 10]. These courses should use asynchronous CMC and collaborative activities to motivate students to participate more.

Collaborative learning is an approach to learning in which students of different abilities and interests work together in small groups in order to solve a problem or complete a project. It involves group activities and active participation, interaction and communication on the part of both students and teachers [11]. The instructor organizes a class into groups and assigns specific tasks or projects to each group. The members of the group are directed to completing a task. Each group member must participate and is responsible for successful completion of the group assignment Group members ought to have well-established "ground rules" that describe how will they interact and work together as a learning community. Each group may have a group leader. The number of members in the group may vary; optimal number for a small closed group is 4-5.

Before the group work starts, the teacher should present students with their assignments, responsibilities, regulations for group work and rules for evaluation of assignments. Group work is organized into several stages: initial stage of forming groups, distribution of group tasks or assignments, autonomous group work on assignments, presentation of results to the teacher and other groups, evaluation of group work and assignments' results.

The critical point in the beginning of group work deals with group forming. Groups could be formed according to the several criteria. Some teachers let students choose with whom they want to work, the other prefer randomly assigning students to groups to maximize their heterogeneity. Many teachers prefer to form the groups themselves, taking into account students' prior achievement or knowledge, levels of preparation, work habits, and gender [5]. Very often, homogenous groups are formed in a way that well-prepared students are placed in groups with other well-prepared students.

During the group work on assignment, members support each other, manage their group activities nd focus on their task. The teacher-facilitator can provide tools and techniques for the tasks, affirm their good work, and stay in the background when not needed. The crucial part in this stage is a well established communication between the group members [11].

The last stage is evaluation which includes students' reflection on their task as well as a task completion check. This allows students to reflect on their own problem solving process: what did and what did not work well in the group and how could the group learning process be improved.

It appears that whether or not small groups improve teaching, both students and teachers generally prefer them. They are animated by participating in the group, and by being able to use problem-based learning. The main problem with the group work is that it costs time. is costly in time.

ICT can be used to reduce this problem and to facilitate collaborative learning. Specially, CMC gives students an opportunity to work on collaborative projects in an online learning environment [4, 9, 16]. On the other hand, teachers need to pay special attention to students in online collaborative learning, because of physical and psychological separation between them [11]. This could be best accomplished by using various forms of asynchronous CMC.

II. AHYCO LMS

A. Necessity for Collaboration and Communication

AHyCo (Adaptive Hypermedia Courseware) is a LMS (learning management system) for development and distribution of adaptive Web-based courseware [1].

The first version of AHyCo had supported only interaction between students and content by using adaptive hypermedia and online tests. The newest version of AHyCo learning management system has an ambition of integrating various collaborative and group oriented interactive modules to enhance its own educational capabilities.

Communication is particularly important in collaborative learning, because learning and successful group work can only occur through continuous exchange of ideas between students within a group and between students and tutor [11, 16]. The appropriate form for both ways of communication is an asynchronous CMC, especially the forum.

The main advantage of asynchronous over synchronous CMC in online learning is participation at "anyplace and anytime". Furthermore, each participant has enough time to think about conversations and to make thoughtful contributions. A record of the interaction is kept and can be reused by both the students and teachers [12].

Therefore, integrating support for discussion groups and, on top of it, various forms of communication has emerged for AHyCo as well. At this point AHyCo's database layer and data access layer are expanded in order to support collaborative work and make it as easy and as natural as possible [17].

B. The model of AHyCo

AHyCo is composed of two environments: an authoring environment and a learning environment. The authoring environment is used by teachers to define adaptive courseware materials (lessons, tests, etc.) in various learning domains. The Web-based learning environment [1] allows a student to log in and study the automatically generated courseware, which can dynamically adapt according to his/her success in acquiring knowledge.

In the development of AHyCo we rely on the Microsoft .NET technology. The AHyCo network application is based on the relational database management system. The components are: Microsoft SQL Server 2000 database, Microsoft Access forms as an interface for authors, middle-tier component for communication between the learning environment and the database, and Microsoft ASP.NET C# Web application as the AHyCo learning environment [10].

AHyCo consists of a domain model, which describes the structure of the learning domain as a set of concepts linked together with prerequisite relationships, a student model encompassing student's knowledge of learning concepts and an adaptive model which contains rules for adaptation [7].

The domain model has a two-level structure and consists of concepts that can be seen as elementary pieces of knowledge for a given learning domain [7]. The first domain level in AHyCo can be presented as a graph with nodes corresponding to the concepts in prerequisite relationships. For example, C_i « C_j means "concept C_i should be learned before concept C_j". AHyCo distinguishes between two types of concepts or graph nodes: lessons C_i and tests T_j. Tests contain questions about the domain lessons.

To split the domain into more manageable units, the concepts are grouped into modules M_k. Therefore, the second level of the domain model is a directed graph that represents the course a student has enrolled to [8]. Each module consists of various numbers of lessons and tests.

For representing the student's knowledge, AHyCo uses a two-level student model, which is a variant of the overlay model [3]. The first level estimates students' knowledge k_i about the lesson C_i and the second level estimates the knowledge km_k about the module M_k.

The adaptation model consists of adaptation rules that define how are the domain model and the student model combined together to support adaptive navigation. Students can freely follow hyperlinks within a module, while the list of offered hyperlinks is dynamically produced according to the tests' results. Navigation within a course is restricted and depends on the student's knowledge value km_k.

Each module M_k has one final test T_f and several mini-tests or quizzes T_j. Assessment model uses mini-tests or quizzes T_j to check students' knowledge and to update the student model (values k_i and km_k) while he/she navigates through the module. To enter to another module, successful completion of the final test is required ($km_k > lm_k$, where lm_k is the minimal acceptable knowledge level for module defined by the teacher-author).

C. Learning and Testing Environments

In order to access AHyCo hypermedia courseware, the student has to log-in by using the Web browser-based interface. The Web pages presented to the student are generated adaptively (on the fly) when student requests them, based on the contents extracted from the database. There are three kinds of pages: lessons, questions and special pages (e.g. log-in page, help, and test results page). The lesson C_i is chosen in accordance to the adaptation rules and the data stored in the student model, to correspond with the students' previous knowledge.

On the bottom of the page presenting a lesson (Fig. 1), the hyperlinks to the continuing lessons C_i or mini-tests T_j proposed by the system are enumerated. The suggested hyperlinks are automatically generated before the page is shown and are annotated with various colors which correspond to concept types (main, recommended, not recommended and read concepts). All the hyperlinks are enabled, so the student could follow any one of them. After the student has finished studying the module's lessons, he/she should choose the final test's hyperlink. Before that, the student can choose all or some of the mini-tests for self-evaluation

The test of n questions consists of n WWW pages. Each WWW page corresponds to a single multiple-choice question (Fig. 2). The test questions and the sequence of offered answers are generated randomly. The student selects an answer and navigates through the test pages by using the common Web interface elements (hyperlinks and buttons). The button entitled "Grading" is used at the end of the testing to store the student's answers in database and to evaluate the test.

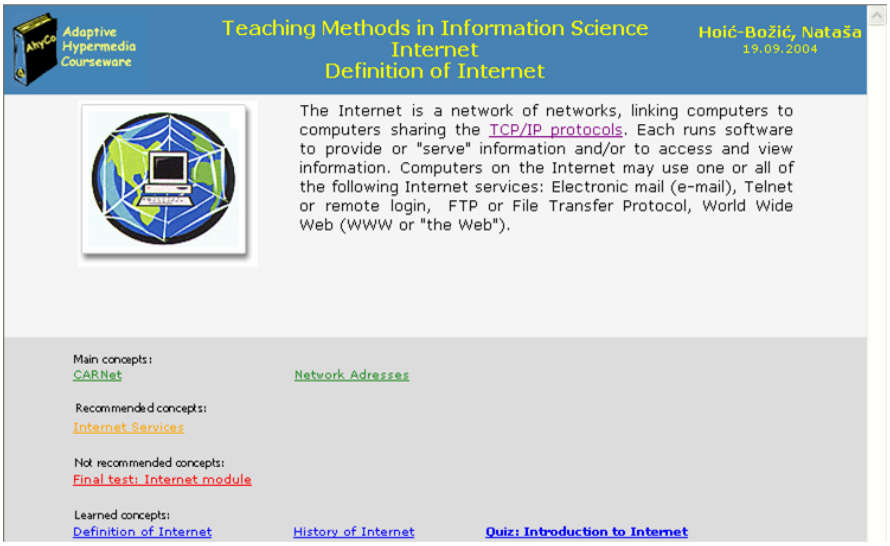

Figure 1. The page with the content of a lesson

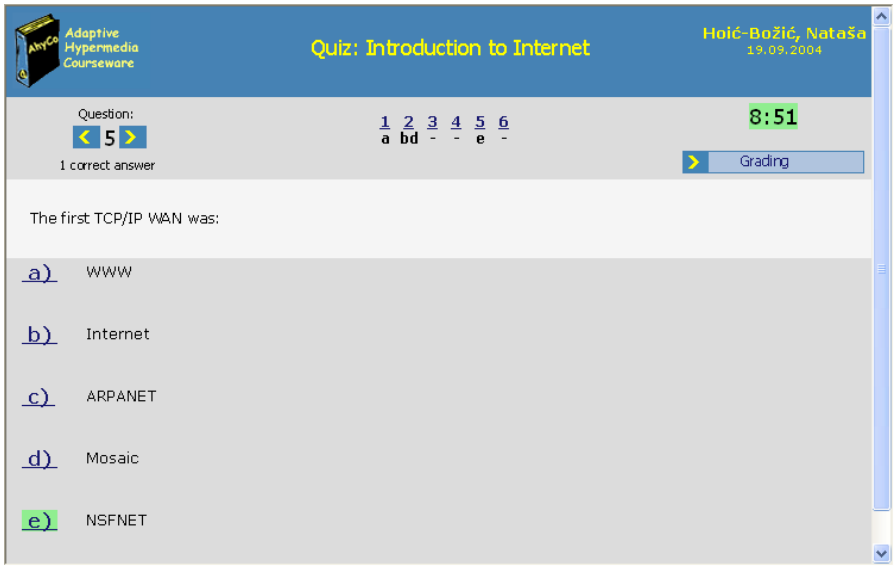

Figure 2. The question page

III. GROUP WORK USING AHYCO

A. *Adaptive group formation*

One of the most tedious jobs a teacher has to do in the beginning of a midterm is to divide students into groups. It is an activity that has to be done quickly and by taking into consideration many different parameters in order to spawn groups that provide pleasant and efficient working environment.

While considering different ways of implementing group formation functionality into AHyCo, some interesting questions arose. We had to consider which input data will suffice. At that point we decided groups will be formed in a way that students' previous success in taken into account so the user interface has been created in order to support adaptive group formation. Figure 3. shows a part where a teacher can choose, what we call, source parameters to determine source data used in the group formation process (more specifically, course and academic year). After choosing source parameters, actual grouping parameters need to be set in order to fine tune group forming process.

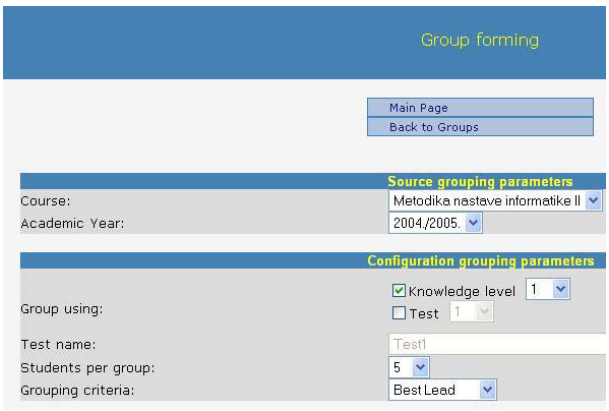

Figure 3. Choosing source parameters for groups

A teacher can decide on whether to use knowledge level, test results or both when creating groups. In addition to that, weight coefficients can be chosen to fine-tune results.

Within the configuration grouping parameters teacher can choose the grouping criteria by which students are to be grouped. AHyCo currently supports two main criteria – for creating homogenous groups and groups which are led by best students.

B. Asynchronous communication using forum

AHyCo's data layer had to be expanded in order to enable various forms of asynchronous communication. Expansion was quite challenging because it had to create a model which was general enough to support various means of communication and, in the other hand, robust enough to enable painless integration into AHyCo [17].

During the process of integration one of the most important goals was to link all existing system's features with newly created modules in order to provide easy and natural navigation throughout the system.

Multi – threaded forum was chosen to be implemented since its structure satisfied user's need for easy message browsing and efficient manipulation. AHyCo's forum supports many-to-many and group-oriented approaches in which students are grouped together and create their own discussions.

Forum (Fig.4) provides many-to-many or group-oriented approaches. One student posts a question or an opinion and the others read it and attach replies. This is a continuous process and the sequence of posts (or a thread) can go on for an indefinite period of time [9].

The forum has advantages over some other many-to-many asynchronous forms such as newsgroups [12]. AHyCo's forum is efficiently integrated into the existing user interface. It is implemented as a set of Web pages so that students navigate and post forum messages more easily.

Depending on which groups a student is enrolled to, he or she can participate in various discussion and see different topics. In addition to that, student in automatically linked to discussions related to the courses he or she has enrolled to. Some discussion can be classified as private and therefore be inaccessible to some students or groups of students.

The role of the teacher is to monitor interactions, encourage students in communication and provide feedback on their questions about content or collaborative work [11, 16]. In addition to that, teachers are responsible for creating forum's discussion groups and discussion themes as well as introducing them into existing system's infrastructure.

C. Files upload subsystem

One of the most important tasks when considering group work support in a LMS is to enable easy exchange of binary files. During the semester students are required to create various files as a result of given assignments which are then shared within the group. Therefore, an intuitive interface was created to facilitate these tasks (Fig 5).

Student can upload a file into desired discussion's group virtual directory. After that action is completed, all students related to the owner of the file (owner or a student who submitted it) can access it through the depicted user interface.

Files can be accessed by students depending on what groups or courses they are enrolled to. When considering group work in a LMS, this is one of the features that makes overall learning experience more efficient and, in the same time, provides extremely high configuration flexibility.

D. Group Grading and Evaluation

Final and, for students, probably the most important stage of group work is grading and evaluation. This stage wants to capture overall group's performance and to quantify it in respect to other groups' results. This stage can be efficiently supported by computer and therefore be integrated into an existing LMS infrastructure as well.

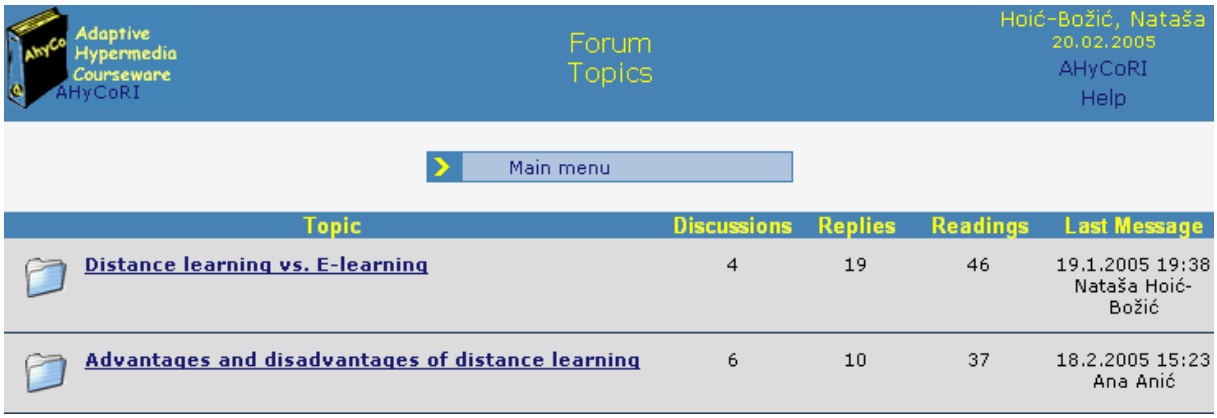

Figure 4. The forum *Topics* Web page

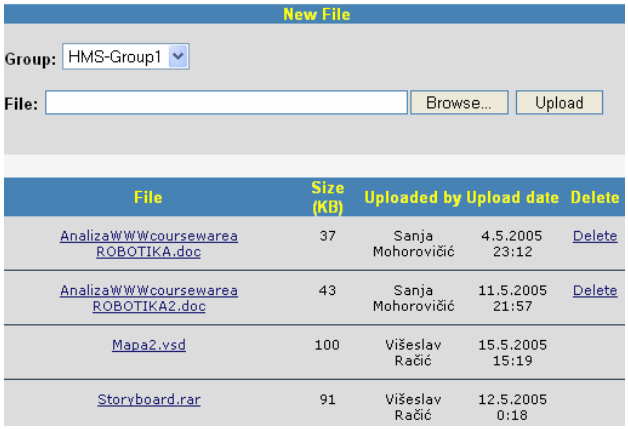

Figure 5. Exchange of binary files

Group grading and evaluation in AHyCo had to be merged with existing discussion group support and was built to support evaluation of group work through the given set of criteria. When a student wants to grade other groups he or she has to navigate to the web page which provides interface to make his or her job as easy as possible (Fig. 6). Student (evaluator) chooses a group to be evaluated and can, at any time, see simple statistics about current group's grades.

Furthermore, in the bottom of the web page, grading criteria, defined by the teacher, are shown. They facilitate overall grading process and provide guidance in grading process for both students and teachers. For each criterion in the list, a grade can be chosen and is then stored in the database. Current grade for a criterion is displayed together with the average grade for each criterion to provide insight into the grading process.

The main purpose of AHyCo's group grading and evaluation module is not only to ease tedious grading process but to provide an overview of existing grading data through the displayed statistics. It is obvious that a teacher can, at any, time see whether all student have completed their grading duties and easy print out a list of final (weighted) grades.

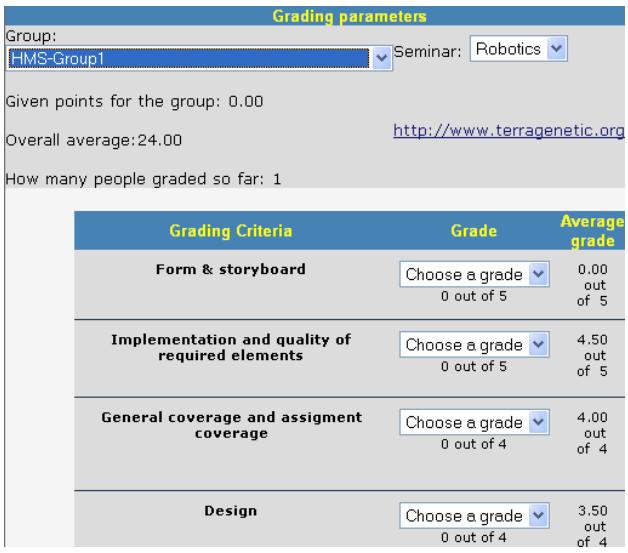

Figure 6. Group grading interface

IV. USING AHYCO SYSTEM FOR LEARNING

AHyCo is currently being used for teaching students at the Department of Computer Science, Faculty of Philosophy, University of Rijeka (approximately 20 students of Information Science). Courseware has been generated for a part of the course "Teaching Methods in Information Science" [8] since we utilize a mixed model of face-to-face and online learning. Online learning activities that include collaborative work and asynchronous communication between students have been supported by AHyCo [17].

The main activities for the course supported by AHyCo are:

- Presenting theoretical course's subject matter as hypermedia AHyCo's modules and testing the students' knowledge by using AHyCo's online tests.
- Students' seminar papers are uploaded to be evaluated by teacher using AHyCo's online testing subsystem.
- Online discussions require that students make regular posts in AHyCo's forum. Topics of discussions are linked with the concepts introduced in course's modules.
- Development of WWW courseware – Students prepare the content about the chosen topic which should be designed in the form of WWW educative presentation and published on the Web server. They work in groups of 3 to 5 managed by AHyCo's group forming subsystem.
- Courseware reflection - A group of students present their WWW courseware and a brief summary of the courseware development process to teacher and other colleagues. Each group evaluates the other groups' courseware according to the defined set of criteria by using AHyCo's group grading interface.

V. CONCLUSIONS AND FUTURE DEVELOPMENT

In this paper the use of AHyCo system for online collaborative learning is presented. Our approach to the collaborative learning and asynchronous communication using AHyCo subsystem for organizing learning groups and forum has been described.

Currently, we are working on further development of the subsystem for group work and CMC. Although AHyCo's collaborative subsystem has reached a level which satisfies its current users (both teachers and students), many further enhancements are planned in order to make it even more attractive:

- Internal messaging system - another form of asynchronous communication which gives students an opportunity to communicate individually without pressure.
- Synchronous whiteboard and chat – these very popular means of communication will be incorporated into AHyCo to extend its interactivity.
- Adaptive regrouping based on students' knowledge level – with this feature AHyCo will be able to monitor students' progress and adaptively regroup students. New groups will reflect current

knowledge levels changes in a way that parameters set by teacher allow.

- Progress supervision and deadline monitoring – the aim of this feature is to help teachers when dealing with large number of students and deadlines for multiple tasks. Its main purpose is to track students' progress and help manage various activities and events.

AHyCo is currently being used in teaching "Teaching Methods in Information Science" course by utilizing a mixed model of face-to-face and online learning.

In order to explore students' attitude concerning online collaborative learning approach, a questionnaire about the level of students' acceptance of AHyCo as a teaching resource was conducted. According to some preliminary results, students accepted the new way of online collaborative learning with AHyCo system quite well. The results have shown that students consider forum to be the most usable component in the system.

All students passed the exam from the first try. The students' average mark was quite high (3,68; the range is from 1-5). Therefore, we can conclude that collaborative online learning was successful, probably because it requires continuous active participation during the academic year and more personal responsibility and concentration when learning from students. In that way, this approach to learning reduces the time needed for preparing the exam, contributes to successfully passing of the exam and ensures deep level learning.

ACKNOWLEDGMENT

The research and development of AHyCo system has been conducted under the projects "Adaptive Hypermedia Courseware" (reference number 2002-085), "Computing support to education" (reference number 0036041), and "Teaching Methods in Information Science Online" (reference number 2004-119) supported by Croatian Ministry of Science, Education and Sports.

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