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Edited by

John G. Meinke
Maryland in Europe Graduate Programs

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THE CONSORTIUM FOR COMPUTING IN SMALL COLLEGES BOARD OF DIRECTORS

FOREWORD

It is indeed a pleasure to present this set of conference proceedings for the Consortium's Southeastern and Northwestern conferences. Based on the contents of this issue, both conferences should prove to be very exciting and valuable conferences for those of us in attendance.

Typically I use this space to give a special thanks to those who have contributed so significantly to this issue. I certainly appreciate all the assistance that I receive in putting together such an issue as this, but am always afraid that I will leave someone out. This time I would simply like to express a general thank you to all, and take a few moments to address the role of the Consortium in this whole process.

The first conference sponsored by the Consortium was the Southeastern conference back in 1987. That one unique conference has now grown into a total of eight regional conferences spread throughout the United States throughout the academic year.

What is the role of the Consortium as the sponsor for these conferences? Each conference establishes its own conference committees and proceeds to organize its conference according to a very general set of guidelines set down by the Board of the Consortium. Those guidelines include the general format -- the conference takes place on a Friday afternoon and Saturday with possible pre- and post-conference activities. The general format of the conference is maintained, with a keynote/opening speaker, parallel sessions on both Friday afternoon and Saturday (to include refereed papers, tutorial presentations, panel discussions, and workshops), a banquet Friday evening with a banquet speaker, and lunch on Saturday. It is important that the refereeing process be established so that each paper presented will represent quality, as well as provide evidence of scholarship for Promotion and Tenure Committees. The Consortium assumes all financial responsibility for the conference.

The Board meets in conjunction with one conference each Fall. Last year's Board meeting was at Northwestern in Beaverton, Oregon, and this year's Board meeting will be in Nashville, Tennessee, at Southeastern. For those of you attending the conferences, let each conference's organizing committee know your feelings about the conference – what is good, and what could use improvement. If the Consortium Board is in attendance at the conference you attend, let the members know the same. In addition, the contact information for the Board members is published with each issue of the Journal – please give the Board your input so that conferences can continually improve.

And now, enjoy the conferences. We, the Consortium Board and the conference committees feel that you will benefit greatly from each of the conferences.

John G. Meinke
Maryland in Europe Graduate Programs
Editor, Conference Proceedings

WEB-BASED ASYNCHRONOUS SUPPORT FOR COLLABORATIVE LEARNING

Kam Hou Vat
Faculty of Science & Technology
University of Macau, Macau
fstkhv@umac.mo
Fax: (853) 837-954

ABSTRACT

This paper investigates the construction of a WWW-enabled course support environment for learner-centered education. The system is designed to encourage students' responsibility, to make learning meaningful, and to support active knowledge construction in the specific curriculums of their study. This system, currently named REAL, carries the connotation of a Rich Environment for Active Learning, whose pedagogy comes from the constructivist's theory of learning. REAL facilitates the interaction among students and teachers by two notions. The first is maintaining a course-specific Web-site for students to look up course-related information. The second is providing a collaborative Web-based service with which students could initiate query requests through using specific inquiry Web-page, which acts as an interactive medium for teachers and students to exchange ideas, record actions, use e-mails, and upload/download files. Each interaction is captured asynchronously and maintained in a searchable archive for other students' reference. The REAL system, developed through the use of iterative prototyping, provides feedback for perceived learning. The paper also discusses lessons learned for teachers developing REAL, in the reflection of instructional methods, as well as some future development of the environment.

1. INTRODUCTION

The technology of the World Wide Web (WWW or Web) is rapidly developing into a powerful, platform independent networked infrastructure of providing integrated solutions in numerous sectors of our society. The use of this emerging technology in education to facilitate the study of our undergraduate students, has become the impetus behind the experimental construction of our Web-based course-support environment which is currently named **REAL** to imply a **R**ich **E**nvironment for **A**ctive **L**earning. In traditional classroom or course setting, teachers often find it hard to recognize students' intellectual and motivational problems, to explain to them a difficult part of the subject matter, to provide clear tasks, and to coach students in specific problem-solving activities. The Web-based environment [10] creates new possibilities to support and enhance this communication within the teacher-student community, while retaining the familiar face-to-face classroom interaction, as one of the essential aspects of a learning process. Also, it is believed that the strength of computer-supported learning, combined with those of instructor-guided learning, could help enable students to become more self-reliant in their studies. As instructional designers, the guiding question in tackling the REAL project is this: How do we create a technology-enhanced learning environment that engages students in the types of activities that will take on their initiative and responsibility for their own learning?

2. PEDAGOGICAL BACKGROUND AND REQUIREMENTS

The REAL system design is based on the pedagogy of constructivism, which, according to Boyle [3], represents the dominant intellectual trend in the design of modern interactive learning environment. Constructivists argue that experiencing and becoming proficient in the process of constructing knowledge is important. Namely, learning how to learn, how to construct and refine new meaning, on the part of the learner, is of most concern. Consequently, we have selected seven basic principles for constructivist design [9], to be considered in the REAL environment. 1) Provide experience of the knowledge construction process. 2) Provide experience in and appreciation of multiple perspectives. 3) Embed learning in realistic and relevant contexts. 4) Encourage ownership and voice in the learning process. 5) Embed learning in social experience. 6) Encourage the use of multiple modes of representation. And 7) Encourage self-awareness of the knowledge construction process. The REAL project is aimed to produce a Web-based course support environment [22] whose focus is put on the needs, skills and interests of the learner, and whose goal is to encourage active exploration and construction in the course of learning activity. The environment believes that educational or teaching practices need be supportive of the work of construction to be done in the minds of the learners [14, 25]. We are to encourage student responsibility, decision making, and intentional learning in an atmosphere of collaboration among students and teachers. We need to promote study and investigation within meaningful, authentic and information-rich contexts. And we have to utilize participation in activities that promote high-level thinking processes, including problem solving, experimentation, original creations, discussion, and examination of topics from multiple perspectives.

3 INSTRUCTIONAL DESIGN OF REAL

We expect the instructional design of the REAL environment should extend the service of a good teacher, by increasing student participation and communication, through re-designing the delivery of college lectures to incorporate more student activity and instructor feedback before, during, and after the contact session. The environment is expected to develop students' ability to generate problems, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use knowledge. From the designers' standpoint, we have included the following enabling ideas [4, 15, 27, 29]:

2. *Enable students to determine what they need to learn through questioning and goal setting.*

It is believed that students should work to identify their knowledge and skill deficits, and to develop strategies in the form of personal learning goals for meeting those deficits. Also, they should learn to relate what they know to what they do not know and ask questions to guide their quest for new knowledge. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the REAL environment, can guide the students in the identification of what they already know and what they need to learn, then knowledge gaps and mistakes can be viewed in a positive way such as another opportunity to learn. And students can assume more responsibility in addressing their own learning needs during any instructional unit.

3. *Enable students to manage their own learning activities.*

It is believed that students should be enabled to develop their learning plans, which should describe priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations, and proposed learning outcomes, including presentation and dissemination of new knowledge and skills, if applicable. Traditionally, these instructional events are arranged by teachers to be obeyed by students throughout a semester or school year, in order to accomplish a specified set of pre-determined objectives. Yet, in that case, it is not advantageous for students to learn to take the initiative. To manage their own learning activities, students must be guided and supported by the teacher, slowly taking on more and more responsibility of their own learning.

4. *Enable students to contribute to each other's learning preferably through collaborative activities.*

It is believed that students should be motivated and supported in discussing and sharing information. Particularly, we should enable the students to become co-builders of the course resources through evaluating and refining the entries their peers put into the course-support environment. Collaborative learning seems appealing to achieve that purpose; however, it involves not just creating a group and then dividing up the work. Students must be educated to recognize what they are trying to learn in group-work, value it, and wish to share that value with others. Teachers can provide this sense of accountability by structuring the group work to include both individual and group assessments.

4 INTERACTION IN WEB-BASED LEARNING

It is understood that interaction is an important component of education and must be intentionally designed into the instructional program in order to improve the quality of learning [18]. This section discusses the salient aspects of interaction in the context of Web-based course support, which have been useful in the design and incremental realization of the REAL environment.

4.1 The Contextual Aspect

The REAL environment recognizes that interaction can be thought of as two-way communication among two or more people within a learning context [1]. This interaction supports such purposes as task completion or social relationship building [12], which includes a means for teacher and learner to receive feedback and for adaptation to occur based upon information and activities with which the participants are engaged [32].

4.2 The Learner-Interface Aspect

The learner-interface aspect [17] addresses the relationship between the learner and the technology that is being used to access course materials and to communicate with the instructor and other students. In the REAL environment, a Web-based interaction has been adopted because the use of the Web browser allows many different media to be accessed through its WWW interface. Besides, it supports such interaction possibilities as: 1) allowing students or instructors to give presentations and to use the Web environment for different types of communication, and permitting linkage to others' presentations; 2) enabling either asynchronous or synchronous communication among participants; and 3) supporting individual or group communication. All these features are meant to enable complex learning activities, such as engaging, reflecting, questioning, answering, pacing, elaborating, discussing, inquiring, problem solving, linking, constructing, analyzing, evaluating, and synthesizing (among others).

4.3 The Pedagogical Aspect

The REAL environment recognizes there are numerous styles of pedagogical interaction. These are represented by such options as one-alone, one-to-one, one-to-many, and many-to-many communication, described by Paulsen [24], as well as the student publication possibility, described by Warschauer [30]. The one-alone style uses online resources such as databases and downloadable applications. The one-to-one style includes apprenticeships and internships. The one-to-many style includes lectures and demonstrations. The many-to-many style includes brainstorming, discussion and project groups. The student publishing style enables students to present their ideas individually or collaboratively, on the Web. These interactions involve respectively the content of the instruction, interpersonal communication, as well as intra-personal reflection integrating new knowledge with that already existing within the learner's life experience.

4.4 The Synchronous/Asynchronous Aspect

The REAL environment recognizes there are two possible modes of communication in interaction: synchronous or asynchronous [2]. Synchronous communication occurs in real time, say, a face-to-face meeting between instructors and students, with all the participants being present, either at the same physical location or at different sites through such technologies as live broadcast or videoconferencing. Asynchronous communication is not dependent upon teachers and students being present together at a specific time/place to conduct learning/teaching activities, though it is often technologically mediated, as in our Web-based support environment. It is experienced that asynchronous communication enables students to work at their own convenience when and where they want, and they can control their own pace of instruction. Meanwhile, synchronous communication, offline or online, requires a facilitator to set the tone or pace of the interaction. This often shifts the focus from learning to teaching or facilitation, and is limited in developing students' initiative for their own study.

4.5 The Individual/Group Aspect

The REAL environment recognizes that many students work alone on the content of a course, and receive feedback only from the instructor in most cases. But if we want to help students to formulate questions of their own and make their own meanings, it is believed that discussion of some kind (though not necessarily with instructors) seems essential. What is needed, are opportunities for the use of group learning models. Moore [21] calls it inter-learner dialogue, which occurs between learners and other learners, alone or in-groups, with or without the real-time presence of an instructor. Also, with the help of technologies such as computer conference, groups can learn through interaction with other groups and within groups. It is noted that such dialogue by learners to learners within and between groups makes it possible for students to share in the creation of knowledge.

4.6 The Feedback Aspect

The REAL environment develops students' initiative and responsibility for their own learning within active and meaningful contexts. Yet, there are times during learning for direct instruction. Namely, we need a teacher's individual attention to motivate the students, to coach the students in the use of problem-solving methods, to explain the descriptions and interpretations of the subject matter, to model the learning and practicing of skills, and to give feedback and corrective guidance. It is this service of personal mentoring/consulting [26] that the REAL environment is suggested to incorporate. The CWIS (Collaborative Web-based Inquiry Service) service is expected to support teacher-student collaboration, make inquiry activity more visible, and facilitate tracking of service usage, and cataloging/archiving of inquiry requests and actions.

5. PRESENTATION DESIGN OF REAL

The REAL environment collectively constitute a course-specific web-site for students to look up course-related information, and the collaborative Web-based inquiry service for students and teachers to interact asynchronously for such activities as initiating inquiry requests, and responding to posted questions. In presentation design, we first explore the design of the course-specific web-site in terms of some service modules (continually expanding) [4], which could be customized for the Web-based learning environment. Then we examine the features of the CWIS service.

5.1 Service Modules of REAL

a) *General Course Information.* This module provides such information as the course description, pre-requisite requirements, evaluation policy, references list, and other details such as time and location of the lectures. It also includes links to the instructor's contact details, his/her teaching/research profile, and the course schedule showing timetable for class with links to the study materials before, during and after contact sessions. Also there is the announcement service representing the most up-to-date information sent to the students from the instructor.

b) *Resources.* This module comprises the study materials prepared by the instructors, and the contributions representing students' submitted or reported work presumably of interest to other students. Study materials can further be cataloged and managed as different resources: study notes, tutorial handouts, supplementary lecture details, or Web-links in the Internet. It could also include frequently asked questions (FAQs) of the course: homework, tests, examinations, and projects.

c) *Inquiry.* This module includes the CWIS service, which comprises such components as *inquiry requests, students, and teachers*. The 'inquiry requests' component points to a list of all pending and completed inquiry requests. The 'students' component points to a list of clients already registered for inquiry service, where the user can add oneself as a client. The 'teachers' component points to a list of consultants available for answering inquiries. It should be noted that adding oneself as a client generates the client's personal Web page (see Section 5.2.1 for more detail) with which the client can initiate an inquiry request, view one's pending and archived inquiry requests, and view statistics about one's own usage of inquiry services. When a client within the personal Web page, initiates a new inquiry request, a form is returned to record the question, and other details such as an expected deadline. This form, once submitted, creates a request Web page for the inquiry request, which serves as the interactive medium between the client and the consultant throughout the inquiry period. Typical interaction through the request Web page includes posting comments, recording actions, using e-mails, sharing related files, and providing feedback and evaluations. When the interaction is completed, it is saved and maintained in a searchable archive, to be viewed and retrieved by other students and teachers for reference purpose.

d) *Assessment.* This module mainly keeps track of student's performance. The score each student obtained after performing a given activity is recorded with enough details to be accumulated for evaluation towards the end of the course. Typical evaluation activities could be based on either individual task or group-supported task. It is important for students to understand that they could propose their own study plan to earn the accumulated score they desire, to complete the course. This service, provided by the Learning Contract [23] component, is used to individualize the learning process for any learner. A student is required to write a formal agreement, which details what will be learned, how the learning will be accomplished, the period of time involved, and the specific evaluation criteria to be used in judging the completion of the learning. Also of interest here is a feedback/negotiate service for students to exchange ideas with the teacher.

5.2 CWIS Design Perspectives

The 'Collaborative Web-based Inquiry Service' (CWIS) is designed to support several requirements of the teacher-student inquiry interaction. These include a) a sense of personal space for an extended collaboration between teacher and student, b) an incremental delivery of inquiry results from teacher to student, and c) visibility of the inquiry interactions to avoid duplicating effort, and to encourage discovery of related interests.

5.2.1 Personal Space. The CWIS service provides both the teachers (consultants) and the students (clients) with their personal Web pages, which are designed to create a personal sense of Web presence. A personal page is where clients and consultants go first when they want to review the progress of or update their inquiry requests, and when they want to start a new request. The personal pages contain personal information such as contact details, say, "mailto" links, which are carried automatically into the action when clients and consultants collaborate from their personal pages, say, causing the request Web page to include their contact information. It is designed that these CWIS-based personal Web pages do not support user-defined features, but allow links to other personally defined Web pages of both the students and the consultants.

5.2.2 Incremental Delivery. When an 'inquiry interaction' is started by the client, a request Web page is generated which is specific to that interaction and to which the consultant and the client return frequently for their interaction. This meeting space on the Web contains all the relevant material required for the specific interaction relevant to each inquiry request. As mentioned, the client's and the consultant's contact information are carried forward on each request Web page so that when the client or consultant is on the page, e-mail or phone call can be easily made. Besides, each page supports several types of interaction: posting comments, recording actions, uploading or downloading file, can be accomplished at any time in any order. This supports the extended discussion and incremental delivery characteristics of the teacher-student collaboration.

5.2.3 Service Visibility. Since the request Web pages for inquiry interaction are visible to any registered student/staff within the Faculty Intranet, and accessible from the CWIS module, it increases the general awareness of the consultant's activities and value. Also, it allows people with similar interests to find one another across the Faculty. More, it allows teachers and students to see if certain questions have already been answered to avoid duplicating efforts. Importantly, when users browse the CWIS inquiry activities, they are always exposed to information about who was involved. This means consultants who specialize in certain topics and clients who have interests in certain areas will start to learn about one another, and hopefully in the long run, they will form communities of interest, as a consequence of the CWIS service.

6 AN EXAMPLE OF COURSE SUPPORT

This section is intended to give an overview of how the REAL environment is used as part of the course experience in the sophomore course, *SFTW 241 Programming Language*

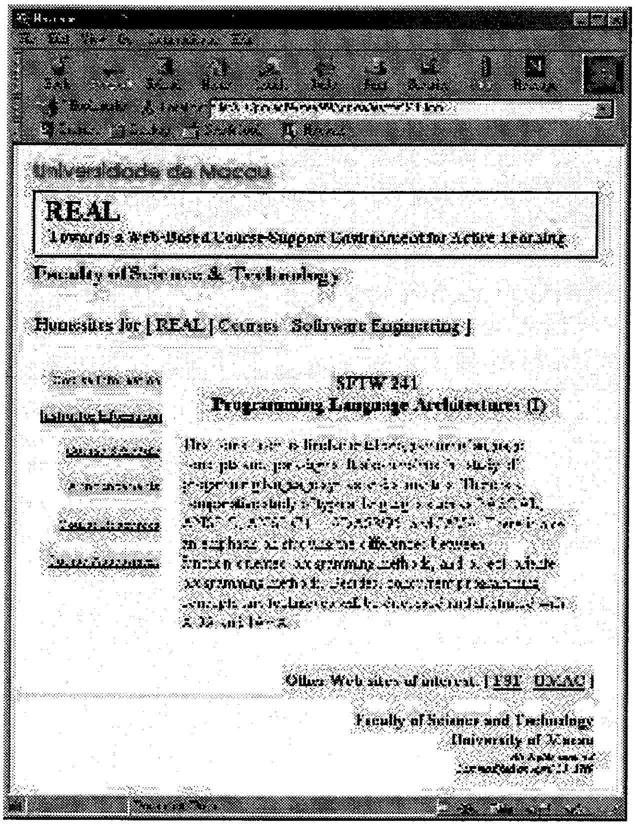

Figure 1: SFTW 241

Architectures (I), offered by the Software Engineering program of the Faculty of Science & Technology at the University of Macau.

6.1 SFTW241 Course Support Environment

The course support environment for SFTW241 (Figure 1) is equipped with some basic features. These include: a) general information of the course, b) course instructor details, c) course schedule including the study materials and the opportunities for instructor-students to give feedback, d) an announcement area for communication from the instructor to the class, and e) course resources containing numerous links to students' contributions related to the continuous build-up of the course-support environment.

6.2 SFTW241 Course Schedule

The schedule (Figure 2) works as a course organizer. For each session, it gives links to self-study activities before the session, to notes for the face-to-face session, and to materials for activities after the session. There is also the feedback space to accommodate students' response after every week's study. The self-study activities mainly involve reading the assigned materials, browsing the related Web links for background information, and preparing questions for discussion during and after the contact session.

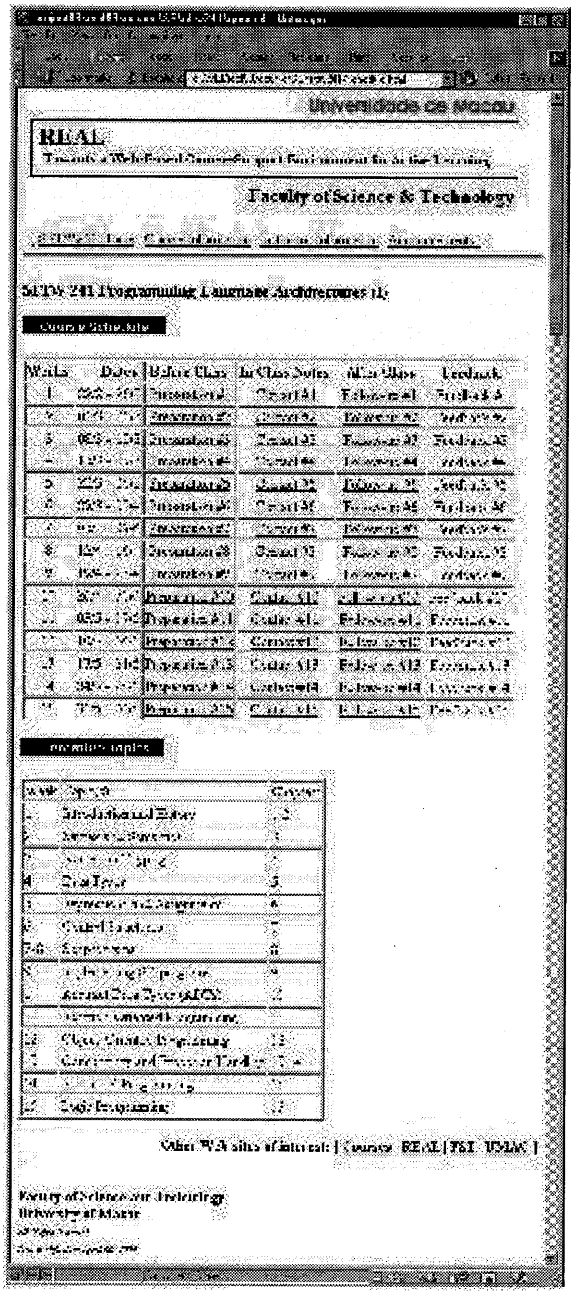

Figure 2: SFTW 241 Course Schedule

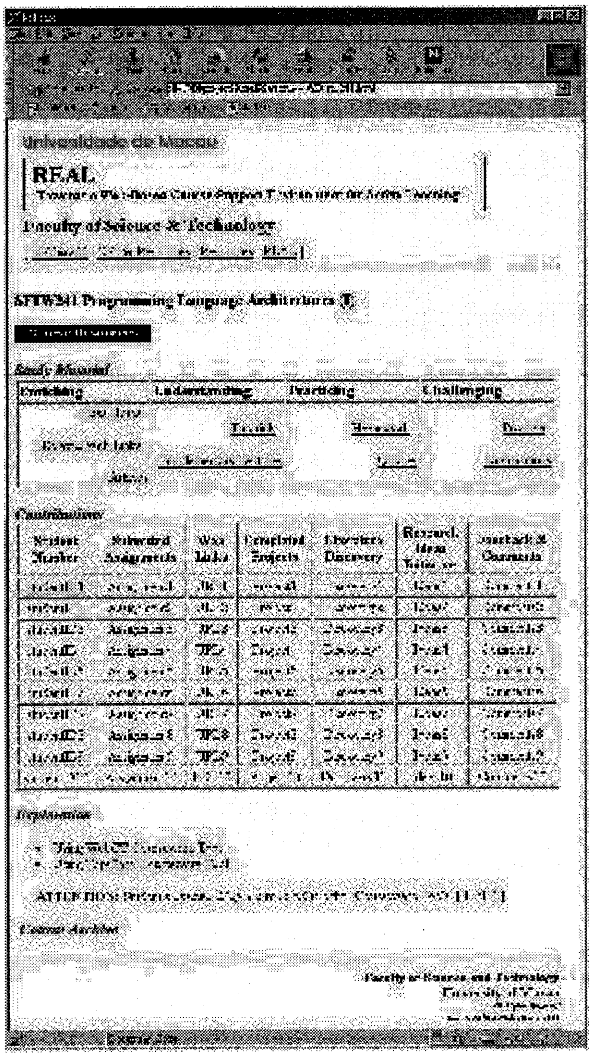

Figure 3: SFTW 241 Course Resources

The follow-up activities include discussion questions which serve to increase students' application of the concepts in the study materials, and also help them to articulate and defend their own ideas, and assignments which lead to the creation of reports, discovery of related literature or the completion of projects. The session notes allow the instructor to update the course materials designed to enhance students' understanding, to add links to provide further exploration, and to illustrate concepts with examples and practical applications.

6.3 SFTW241 Course Resources

The course resources (Figures 3 & 4), though undergoing continuous update, is designed to come close to the constructivist's ideas of active learning. The resource site is used as a support for the course, to lead the students to decide for themselves what extra materials they wish to select and study. Students need to post their assignments, reports or discoveries on the course site for peer review. The instructor could also provide coaching and comments on an individual basis when required. To facilitate students' exploration, some external courseware tools such as WebCT [13] and TopClass [31] are also incorporated when useful.

6.4 SFTW241 Course Assessment

The goal of the course-support environment is to support students' self-responsibility for learning. Yet, students often need a push in terms of points given to acknowledge their contributions. The Assessment module of the REAL environment

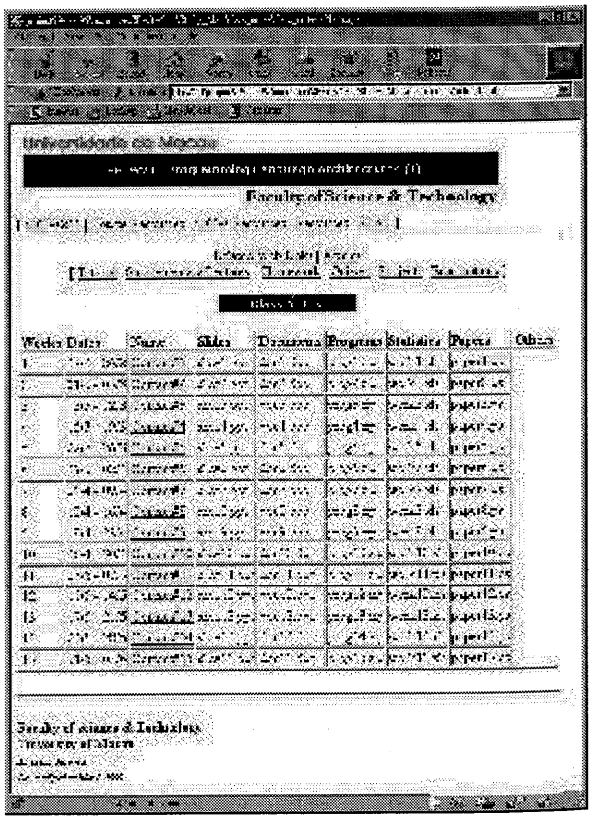

Figure 4: SFTW 241 Course Notes

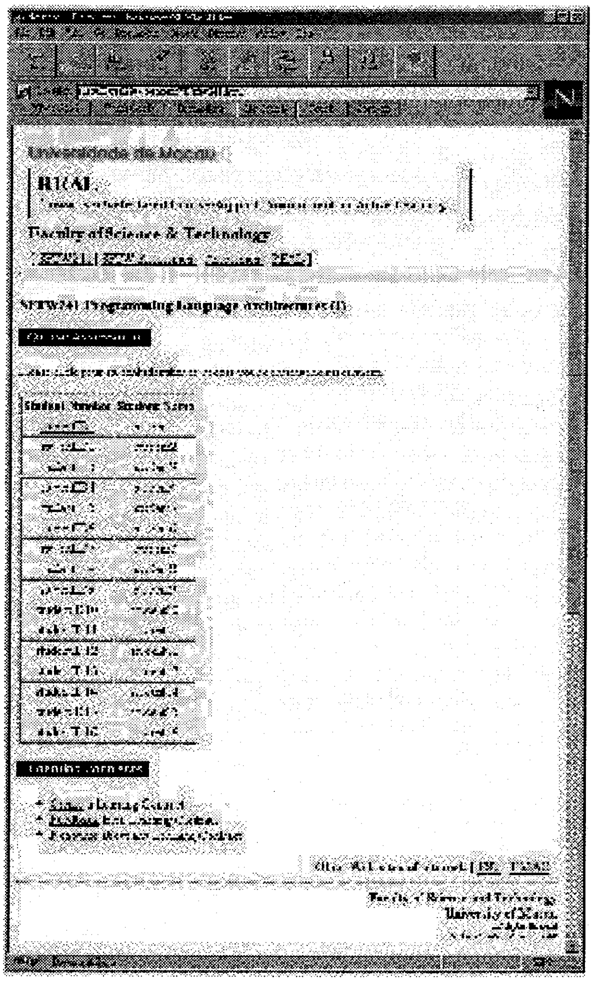

Figure 5: SFTW 241 Student Course Assessment

provides students opportunities to go directly to a specific course assessment (Figures 5 & 6) to look up the scores obtained for specific assignments or self-initiated activities, such as those indicated in the Contributions of the Course Resources page. It also provides the convenience for students to write up their own Learning Contracts to submit for approval. To find out the result of submitting the Learning Contract, the student clicks the Feedback link to access the specific result page. If disapproved, the student can click the Negotiate link to re-submit the modified contract. This interaction enables students to determine what they need to learn through questioning and goal setting. It is meant to encourage ownership and voice in the learning process.

7. AN ILLUSTRATION OF CWIS SERVICE

The CWIS module (Figure 7) is one of the six major service modules incorporated in the REAL environment. Both students and teachers are provided with their own areas on the CWIS site, where they can get to by clicking the Teachers or Students links. Clicking the Inquiry Requests link takes the users to an area where they can get a list of all pending and archived collaborative inquiry requests. Clicking the Feedback link allows the user to feedback comments for future system improvement.

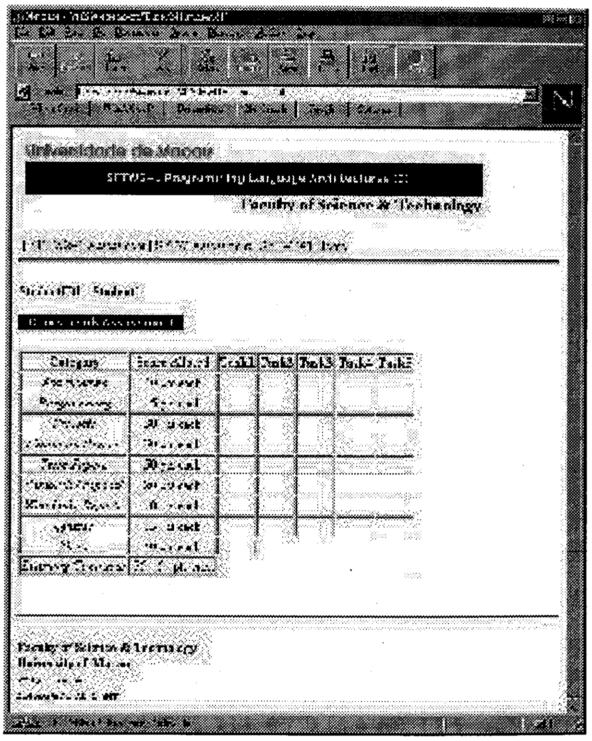

Figure 6: SFTW 241 Individual Student Assessment

The Teachers link (Figure 8) provides students with a number of teachers/consultants to choose from when initiating an inquiry. Each of the consultant links leads to a personal profile as well as the pending and closed inquiries of the teacher. From a specific teacher's personal Web page (Figure 9), we can go deeply into the teacher's background information, including research/teaching details. We can also look into the pending and closed inquiries of that teacher. Through the individual inquiry links made available, we can further go directly to see the details of any inquiry be it pending or closed.

The Students link (Figure 10) provides users with the information on the current clients

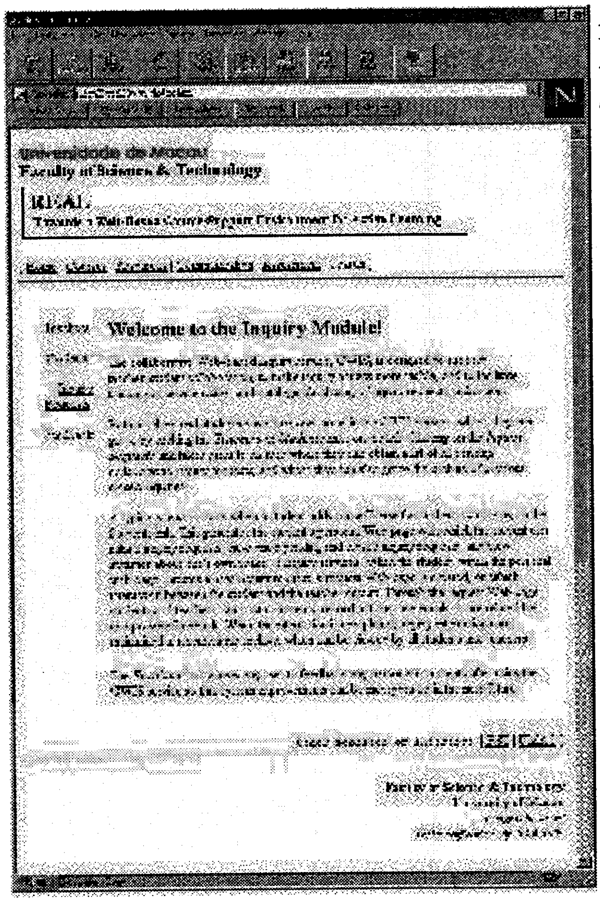

Figure 7: CWIS Module

of the CWIS service, allows the user to add oneself as CWIS client, and to view the current pending and closed inquiries of the module. Clicking on the Clients Listing (Figure 11) shows the current set of students already added as clients of the CWIS service. Clicking on the individual student's link on the clients listing brings up the student's personal Web page (Figure 12) created after the student has added oneself as the CWIS client.

When a client initiates a new inquiry request within the student's personal Web page, a form is returned to record the question. The form also allows the client to select a consultant and to specify an expected deadline. This form, when submitted, creates a request Web page (Figure 13) for the specific inquiry request. This newly created request is also entered into the student's and the consultant's pending requests. This request Web page serves as the interactive

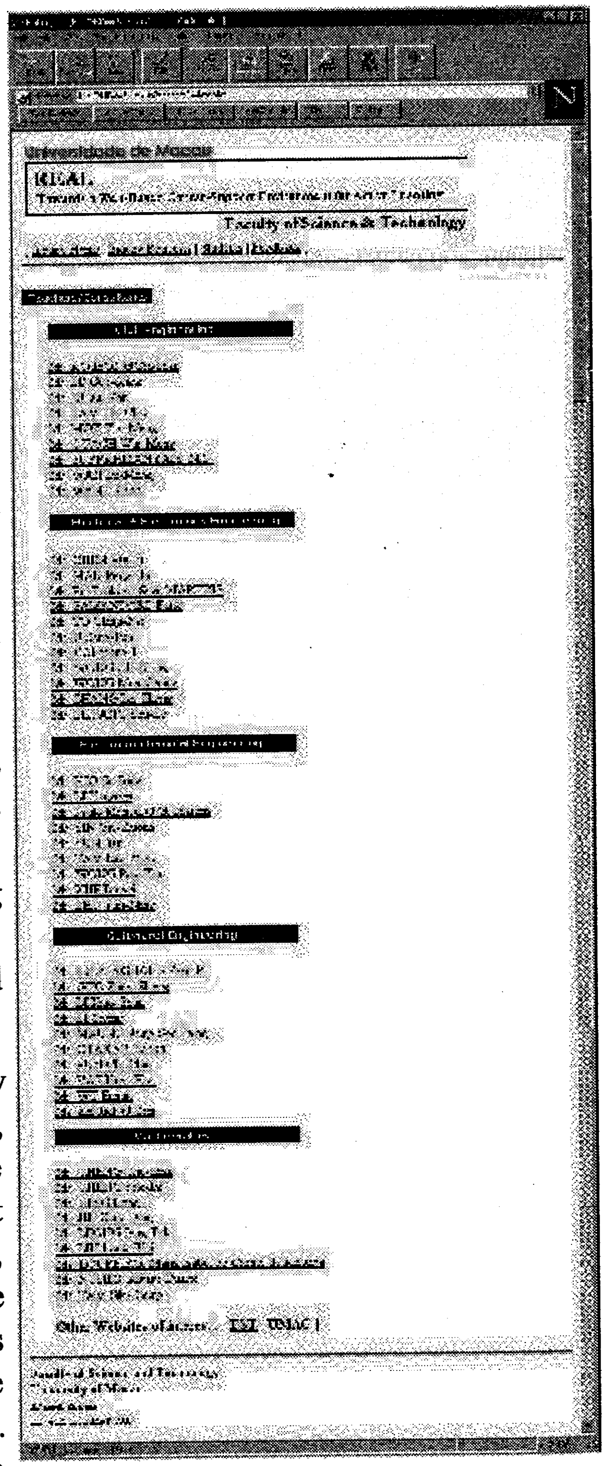
Figure 8: Teachers Link

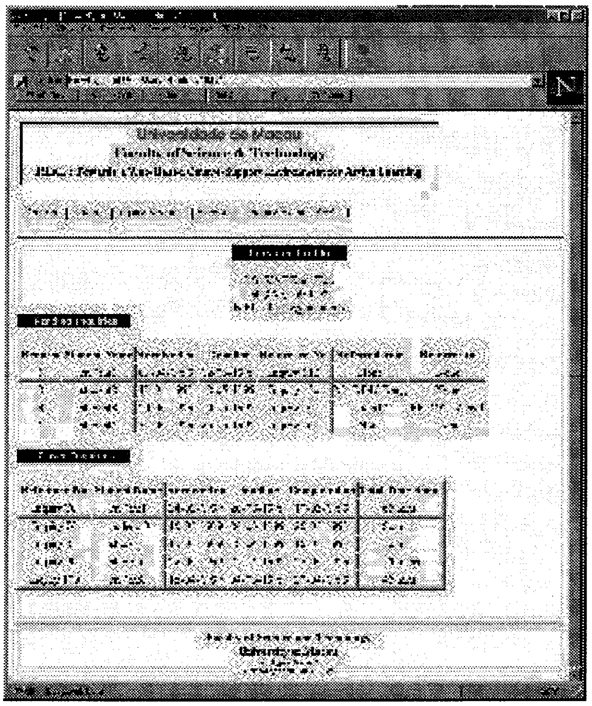

Figure 9: Teacher's Personal Web Page

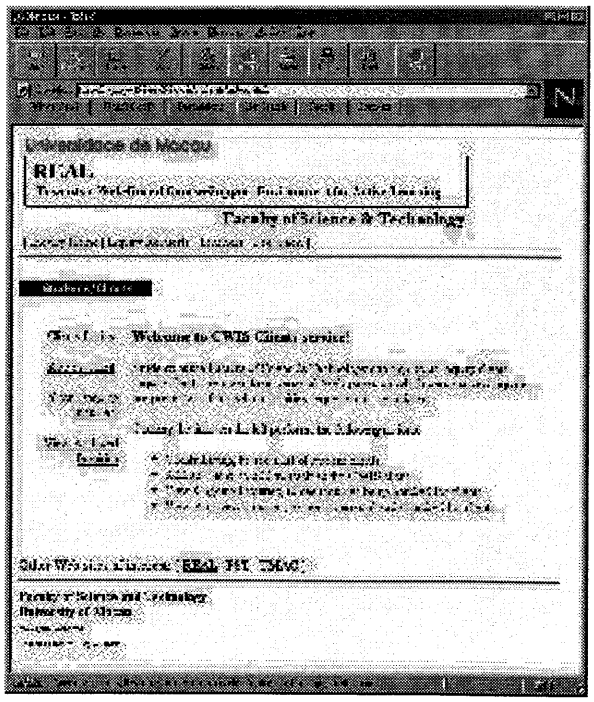

Figure 10: Students Link

medium between the student client and the consultant. It carries the inquiry reference, say, Inquiry 112, the date when the request is posted, and the expected due date when the request should be completed. Also made available are the client's and the consultant's contact details. The following (Figures 13 & 14) show the newly created request Web page for Inquiry 112, as well as the same Web page after some collaboration from among the consultant, the student client, and other interested parties. All interactions between the client and the consultant occur on the inquiry Web page. This page is used to record all actions and provides information on the progress of each inquiry. The inquiry Web page has links back to the client's or the consultant's personal pages. All pending inquiries have the status set to open, which could be changed to closed when the consultant completes the request. In the upper right portion of the page, the client's question appears in full. Below that is the interaction area where comments and actions are recorded, and where files may be downloaded and uploaded.

It is designed that clicking on the Comments, Actions, and Files links brings up a form appropriate to the activity to be returned. Entering suitable information into the response forms, and submitting the form, causes the action to appear as shown under suitable headings. It should be noted that links to the commentators' personal Web pages provide social networking opportunities for the informal collaborative experience in learning. Also each action is appended with the time taken for the specific activity. The times for individual actions are accumulated on the time usage item on the upper left portion of the page. The Files form allows the consultant to upload any file from their desktop to the web-site. Each file listing could be a hyperlink so that when a user clicks on the specific file link, that file is then downloaded to one's computer. When an inquiry request is completed, the consultant closes the inquiry by changing the status to closed, and fills in another form to enter summary of what was done, and send request to the

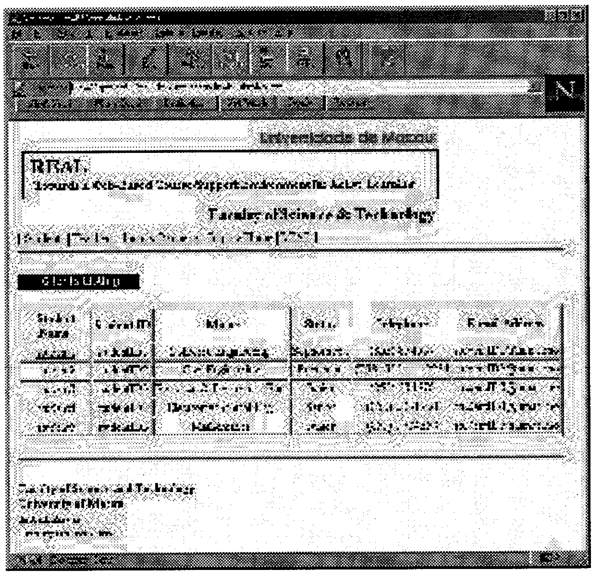

Figure 11: Clients Listing

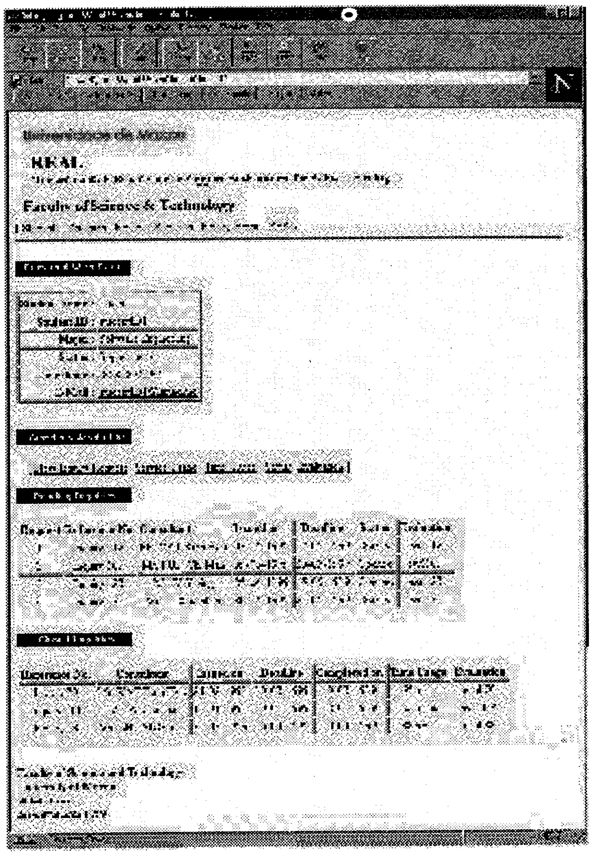

Figure 12: Student Personal Web Page

client to ask for feedback on the inquiry request. The request is then entered into both the client's and the consultant's closed inquiries, as well as the CWIS archived inquiries.

8. DISCUSSION

The REAL project represents an initiative to stimulate and steer the innovative and appropriate use of the World Wide Web for course-support purposes within the faculty, in order to make our educational delivery more efficient, more enriched, and more learner-centered. The project evolved from an initial thinking of how to apply the Web technologies to the delivery of course notes in the author's courses of teaching assignment. The present ideas of integrating into the course environment, extra opportunities for students' contribution of additional learning resources, and for Web-based collaborative inquiry service, turned out to be the continuous collaboration among students and instructors, apart from adding a preparation for and some follow-up from each face-to-face session. Presently, the Web-based course-support environment can be conceptualized as an information-communicationexchange environment, which is enabled to support some interaction aspects of Web-based learning as mentioned in Section 4. This is made possible in the REAL environment by resorting to the strategy of providing flexible service modules, customizable for any specific variation. An example is the possible accommodation of external courseware tools such as WebCT [13] and/or TopClass [31], each of which constitutes software that handles the design, delivery, and management of whole courses online (See [11] for more comparative analysis).

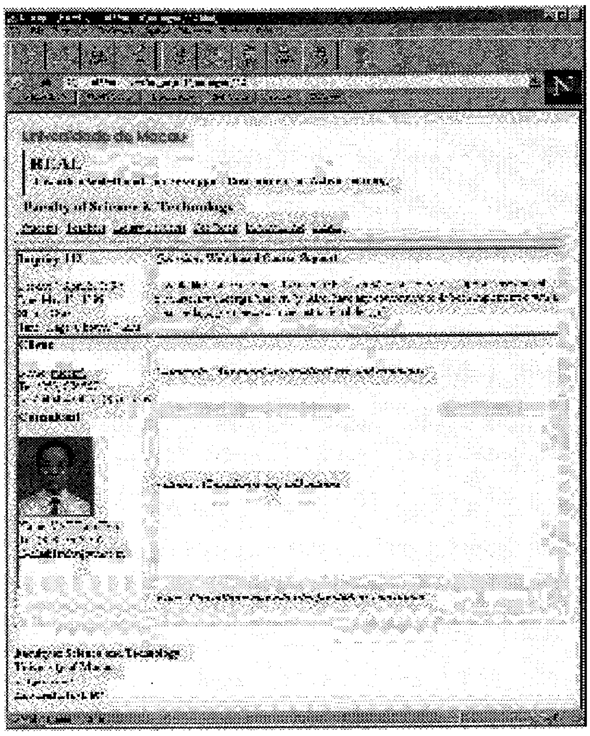

Figure 13: A Newly created Inquiry Web Page

Yet, it is the author's belief that technology adoption, as in the use of courseware tools, must be based on understanding the link between design and use. But, how does design relate to use? The development of the REAL environment demonstrates that as instruction begins to move towards more learner-centered, the instructional design process must include a number of strategies to accommodate the likely needs of users (teachers/learners). One example is participatory design among the instructional designer, teachers and students in developing the REAL environment by using the user-driven iterative prototyping approach. This involves creating a series of function prototypes used to clarify the objectives of the system in light of design exploration between the designer and the users (teachers and students), so that the users gradually understand what can be achieved with the technology. It is understood that staff engagement [8] is the critical component of the REAL initiative whose implementation success lies on their accepting the innovations involved in the instructional practice, and their willing cooperation to teach in the new ways with the Web technologies. We believe that an institutional culture must be ready that rewards not only research productivity in terms of technical innovation, but also pedagogical re-design effort in terms of quality teaching.

9. LESSONS LEARNED

As designers of learning environments, we are often confronted with such basic question as: What should be the outcomes of the learning process? Laurillard [19], an educationalist, argues that the production of a clear set of educational objectives at the start of a project

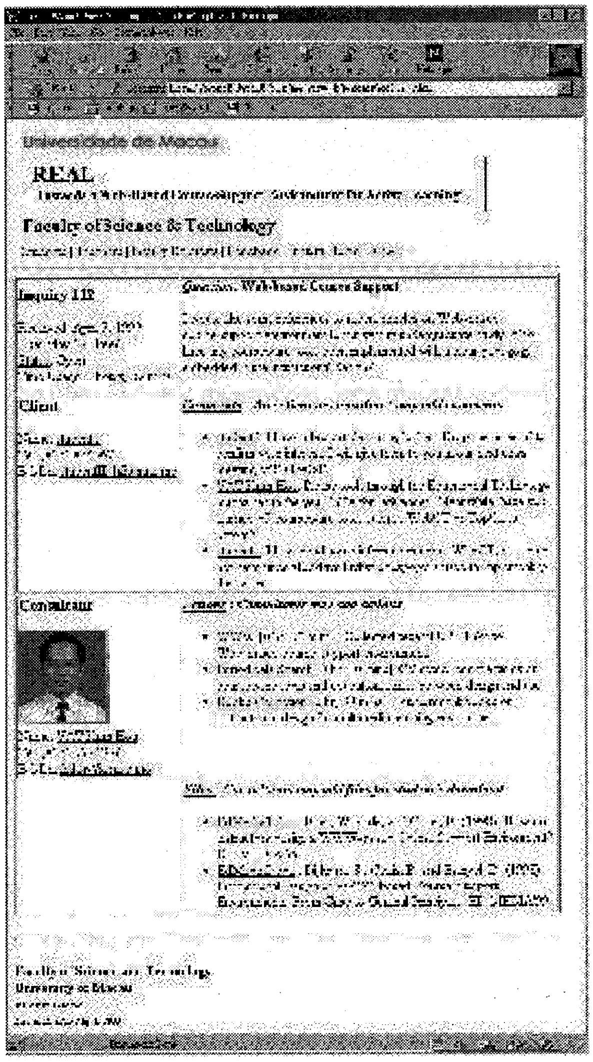

Figure 14: An Inquiry Web Page Being Processed

is crucial. Nevertheless, Vaughan [28], a commercial multimedia designer, suggests that the objectives of the project are something that evolves from an initial inspiration. There may be a considerable amount of work in developing the initial idea into a specification of the objectives for a project. Laurillard proposes two main activities that are relevant in the specification. The first is to state the perceived requirements for a course in a particular area, in terms of a series of curriculum-derived objectives, each of which should be stated precisely so that it can be clearly agreed when the student has achieved the same. These objectives collectively specify the appropriate outcomes at the end of the course, i.e., knowledge and skills acquired by the students in certain content areas. The second major activity is to assess the students' conceptions and skills at the beginning of the course to find out the problems and misconceptions the students may have in tackling the subject, through a range of techniques such as tests, assignments and interviews. It is only after clarifying the target attainment and the students' problems that the educationalist would start designing the learning materials. On the other hand, Vaughan recommends the use of a feasibility study before the objectives are finalized. This may involve building a skeletal version of the system whose demonstration helps clients to clarify what is really required. The formative assessment derived from the examination of this skeletal prototype leads to a clarification of a number of analytic issues. The statement of objectives and supporting information for project management can then be finalized as a result of the information obtained.

It is against this backdrop that the REAL project has been tackled from an initial inspiration of the Web technology. Obviously, the educational objectives have to be mapped onto the possibilities and constraints of this chosen technology. Indeed, the construction of the REAL environment can be considered as a creative act out of the interplay between inspiration and the educational formalisms which discipline the shape of our project. The following lessons learned from our experience in working out the project objectives represent the current result of this interplay:

- The Web-based course-support environment should extend the boundaries of the traditional classroom teaching.
- It should include a resource center for investigating a variety of information items, with an emphasis on the students evaluating this additional information in terms of its meaningfulness to the course.
- It should provide a convenient channel for students to participate in collaborative work and in the communication of ideas and questions, in ways that cannot take place in the classroom owing to restricted time and the difficulty of making reflective comments in a classroom setting.
- It should support students' original thinking, discussion, exchange of ideas, and peer evaluation. It should also allow students to organize and restructure information items as well as create and contribute their own resources. The course environment must be technically able and flexible to grow during the process of the course, based on students' entries. Also, these activities should be encouraged through suitable grading in the course.

10. FURTHER DEVELOPMENT

It is observed that group-based project work [16] which focuses on collaborative learning among group members, giving authentic opportunities for students to articulate and defend their ideas and to reach consensus on decisions in tackling a complex task, has been an increasingly used instructional strategy in higher education. In an educational context, Collis [5, 6] indicated that there are certain problems, which have to be managed by the instructor and the group members. The major issues involve maintaining course cohesion and momentum as students become immersed in their respective projects. Next comes the problem of motivating and structuring collaboration and communication. The third concern is to maintain group memory such as project-management related information, in relation to organizing and executing self- and group evaluation. The last question is relating group activities and product outcomes to conceptual aspects of the course, to study materials, and to individual assessment in examinations. In order to make collaborative group-based project work, the REAL environment requires suitable combinations of instructional strategies and Web-based course-support. Its variation [10] indeed depends on many factors. This can be considered as one of the future enhancements in the REAL environment.

11. CONCLUSION

The REAL project, aimed to produce a Web-based course-support environment for active learning among undergraduate students, has been described in this paper, according to its instructional and presentation design. And it is the author's belief that it is the instructional design, not merely the delivery system of the Web that sets the quality on the educational experience of the REAL environment. Instructional design can be considered as a process for planning episodes of learning sessions that feature interaction, learner control, and mutual feedback. Presentation design maps the abstractions of the instructional design onto the REAL environment. It involves the holistic construction of the various service modules, including their presentation structures [20], i.e., the combination of the "look and feel" of the Web pages and the navigation paths the visitor can take through the site and the software artifacts to accomplish these purposes.

Presently, the REAL environment provides a Web-based instructional interface which does not constitute just one-way delivery of course information, but rather the opportunity for access to class material, a gateway leading the learner to numerous resources, and a method to facilitate communications among the learner, the instructor, and other students. In particular, the CWIS service is believed to bring out authentic learning activities. The essence is a student being personally confronted by a problem to be solved, or a project to be completed. This challenge causes the inquiry to be personally meaningful for the student and through interaction with the instructor or/and other parties, an explicit formulation of the topic being examined, and the process used for solving the problem, is constructed, with the possible resources provided. It is expected that active learning occurs when both the process and the tentative solutions are being studied and reflected upon by the individual student.

As for the software artifacts, the REAL environment is composed of various classes of Web-based applications such as the static HTML-based, the server-side (CGI-based), and the client-side (Java-based or JavaScript-based). And its engineering is an involving process because of the availability of numerous infrastructure options such as Web servers, Web gateways, Java versus CGI-based development, distributed object middleware, data access technologies, and network configurations. Indeed, these various options of technological innovations have brought us a rapidly emerging information society, to keep up with, including the processes of our education, which need to adapt responsively. It is the author's belief that the REAL environment, our Web-based course-support project, represents the potential to effect such adaptations in education. To that end, we need to be more involved in addressing the pedagogical issues, besides the technological possibilities.

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