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Web Environments for Group-Based Project Work in Higher Education

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We discuss problems confronting the use of group-based project work as an instructional strategy in higher education and describe two courses in which course-specific World Wide Web (Web) environments have evolved over a series of course sequences and are used both as tool environments for group-process support and as the product environment of the project work itself. In particular we describe the use of specific Web-embedded shared workspace, communication-management and evaluation tools and their contribution to the management and educational value of group-based project work. The integration of instructional principles and strategies with the Web-based tools is also of particular importance. The 1996-97 versions of the courses analysed in this article can be found at http://www.to.utwente.nl/ism/ism1-96/home.htm for the first-year course in educational media design, and at www.edu.cs.utwente.nl/~aitnlpbg/, for the first-year course in applications of information technology. Both courses, at the University of Twente, use group-based project work as a major organizational form, but integrate all aspects of the courses within cohesive Web environments.

GROUP-BASED PROJECT WORK AS AN EDUCATIONAL STRATEGY

Before describing Web-based tools to support group-based project work in higher education in two specific courses at the University of Twente, it is appropriate to first review key dimensions of such project work and also key issues for both instructor and students in courses that make use of group-based projects as major components.

Definitions and Dimensions

Group-based project work, or project-based education, is a form of instructional organization with a long history. Project work can be advocated for its professional or vocational value, as a way to embody experience within a social-constructivist process and as an instructional strategy for problem-solving development. Group-based project work allows the tackling of a complex task, too complex for one person to handle alone, and also provides learning experiences in group interaction, providing authentic opportunities for students to articulate and defend their ideas and to reach consensus on decisions as well as on work-flow management (Guzdial et al., 1996). Group-based project work is a frequently used instructional strategy, particularly in higher education domains where design work and problem-solving tasks involving complex systems are an object of study. (See, for example, Klemm and Snell, 1996, who discuss the value of group-based project work in areas including public health and neuroscience, and Van Oort and Van Woerden, 1996, for engineering education.)

Key Variables and Associated Concerns

Group-based project work in an educational context can take many forms, varying on key dimensions such as the degree of openness in the problem being addressed via the project activities, the way in which individual and group responsibility is apportioned, the extent to which the instructor steers and intervenes in project activities, the way evaluation occurs, and the relationship of the project to the course in which it is situated. In addition, the tools available to the group members for their task-related activities, as well as the nature of the deliverables, partial products, and group-memory resources, all have an effect on the nature and success of group-based projects (Collis, 1994; Heeren, 1996). Major variable clusters

relate to communication support, to resource-handling support, to group-aspect support (including both task-related aspects and social-dynamic aspects), and the integration of all these with the conceptual aspects of the course as well as with the rest of the course organization in which the project is embedded (Collis & Smith, 1997).

In particular, the following clusters of problems need to be managed when group-based project work is used as a form of instructional organization in a course (Collis, Andernach, & Van Diepen, 1996; Van Oort & Van Woerden, 1996):

- problems in maintaining course cohesion and momentum as students become immersed in their respective projects;
- problems in motivating and structuring collaboration;
- problems in motivating and structuring communication;
- problems in maintaining a "group memory;"
- problems in organizing and executing self- and intergroup evaluation;
- and, problems in relating group activities and product outcomes to conceptual aspects of the course, study materials, and individual assessment in examinations.

Instructional Strategies and Web-Based Tools in Response to Problems With Group-Based Project Work

In our experiences with group-based project work in higher education over a number of years, and in our experiences with the use of Web-based tools and environments to support such project work beginning in 1994 (Bos, Morgan, & Kikstra, 1996; Collis, 1996a, 1996b, 1997; Collis, Andernach, & Van Diepen, 1996; Collis & Breman, 1997; Collis & Meeuwsen, 1997; Pouw, Terlouw, Joosten, & Van Diepen, 1995; Van Diepen & Pouw, 1995), we have evolved the various combinations of instructional strategies and Web-based tools in response to these general clusters of problems. Table 1 shows some of these. In the remainder of this article, we illustrate some of these responses via examples from two particular courses, both for first-year students at the University of Twente.

Table 1
Problems in Group-Based Project Work, Instructional Strategies, and Web-Based Support

Persistent Problems in Group-Based Project Work:	**Instructional Strategies and Web-Based Support in Response to the Problems:**
Problems in maintaining course cohesion and momentum as students become immersed in their respective projects	-Integrate all aspects of the course, theoretical and project-related, in a single course Web site, accessible to all and making group progress visible to all -Link student work, in partial or completed form, to the course site, for use as examples and study material for self-study as for demonstration and comment during lectures
Problems in motivating and structuring collaboration	-Choose a task where the common product is motivating in itself; where a team approach is needed to handle the various aspects of the task; and where an instructional strategy such as the Jigsaw Methodology, whereby each group member has clearly defined and separate contributions to the group (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), is built into course requirements
Problems in motivating and structuring communication	-Develop a strategy of having a manager in each group responsible for reporting group progress and group reflection, via embedded email, newsgroups, CGI forms, and other tools, available in the course Web site, and with results of this input linked into the course site so that a group archive is built from the communication
Problems in maintaining a “group memory”	-Use tools with shared workspace functionalities integrated in the course Web site so that a common view of notes, partial products and other project-management related information are available to all
Problems in organizing and executing self- and intergroup evaluation	-Use the course Web site as the product as well as the process environment, so that partial and final products are available for self- group, peer and instructor evaluation, using structured evaluation instruments (CGI forms) also integrated into the course site; post and use these various forms of evaluation as basis for final evaluation of the group product (Collis & Meeuwsen, 1997)

Table 1 (continued)
Problems in Group-Based Project Work, Instructional Strategies, and Web-Based Support

Problems in relating group activities and product outcomes to conceptual aspects of the course, to study materials, and to individual assessment in examinations	-Use comparisons of group products, relative to conceptual issues in the course, as question on the examination; link criteria for on-going self-evaluation of group products to study materials and lecture notes also embedded in the course site

On-Going Research and Educational Questions Relating to Project Work and Web-Based Environments

There are many different strands of research and development work relating to the improved support of group-based project work in education. Some relate more directly to learning-related aspects (Slavin, 1990), some to a focus on instructional organization (Gokhale, 1995), some to particular software tools (McManus & Aiken, 1995; Michailidis & Rada, 1996), some relating to CSCW (computer-based cooperative work) perspectives (Heeren, 1996), and some particularly to Web-based tools and strategies (Collis, 1997; Klemm & Snell, 1996). The general question motivating our own research and instruction is "What combinations of pedagogical and managerial strategies, and Web-based tools and environments can improve the efficiency and educational effectiveness of group-based project work?"

One simple restatement of this question is "How can the Web be used as a learning tool for project work?" After the following description of two of our courses, in which all the problems indicated in Table 1 occur, and all the responses are also in operation, we will return to this question in a description of our new research activities.

EXAMPLES FROM PRACTICE: TWO FIRST-YEAR COURSES AT THE UNIVERSITY OF TWENTE

First, the two courses to be used as illustrations will be briefly described. Then each of the problem areas identified in Table 1 will be focused upon, with examples from one or both of the courses.

Descriptions of the Courses

Instrumentation Technology 1 (ISM-1) is a required course for students entering the Faculty of Educational Science and Technology at the University of Twente. These are generally students directly out of secondary school, thus approximately 19 years old. The general objectives of the course are to introduce these students to the field and study of educational technology, with a particular focus on the process of designing and developing computer-based learning materials. The course is organized around three group projects, one per trimester, in which students work in groups of eight or nine, and within each group have different roles relative to the particular design task. In each project, the students begin with a problem and a well-defined target group and must design and produce various media products as a solution to the problem. The media products include interactive Web sites with questions and feedback programmed in JavaScript and incorporating images, audio segments, and digital movies, as well as desktop-published print materials. There are five lectures per project and a sixth communal setting in which each group presents its final products. The rest of the course organization revolves around the project work. Students complete each project with a written examination, in which they receive an individual grade. Their work on the project is generally graded as a group (with the possibility that an individual student who has not met his or her group responsibilities can be given a different grade, at the instructor's judgement). In the 1996-97 cohort, there were 80 students, several of whom were part-time. (For a fuller description, see Collis, Verhagen, Gervedink, & Meeuwsen, 1996.)

A particular feature of the course is the emphasis on self-organization of work and on responsibility to one's group. A half day of time in one of the faculty's computer laboratories and in a workroom with large tables, cabinets for the use of the groups, and additional computers is allocated to each group per week, but students are not being led by an instructor or laboratory support person at those times. Students must learn to work independently, following the instructions for the week and completing set tasks for the week.

Applications of Information Technology (AIT) is a compulsory course for first-year students in business information technology (BIT), associated with the Department of Computer Science at the University of Twente. The business information technology curriculum started in 1993 to bridge the gap between computer science and business administration. The AIT course makes this bridge very explicit, by using information technology to

study applications of information technology. AIT provides an introduction to the full spectrum of applications of information technology, allowing students to zoom in on specific applications. The course emphasizes the role of the technology in organizations rather than the technology itself. Thus, the course serves to motivate the students for what is coming in the remaining curriculum and makes sure that they can relate theory to practice. A special feature of the course is the experience of working collaboratively on the major course project with students taking a similar course at the Kuopio Vocational Education Centre and the Pohjois-Savo Polytechnic in Finland via the Internet.

Students work in project groups each of which consists of about six Dutch and three Finnish students. Efforts of the group are to yield a collaboratively produced report about a selected topic related to applications of information technology in business, in the form of a set of Web pages in which individual contributions of the group members are integrated. The course takes 9 weeks, each consisting of two sessions of 4 hours each. A group arranges its own work, making sure that the next week's commitments are kept. Tutorial sessions for the course stress the relation of the project to the content of the course textbook. Supervision contacts are maintained with each local subgroup to check progress, to account for the commitments due, to stimulate improving the work, and to ensure that delivery of the final document is guaranteed.

Use of Web-Based Tools and Environments for Maintaining Course Integration, Technically and Conceptually

The first and last of the problem clusters identified in Table 1, and responses to the cluster, are shown again below:

Problems in maintaining course cohesion and momentum as students become immersed in their respective projects	-Integrate all aspects of the course, theoretical and project-related, in a single course Web site, accessible to all and making group progress visible to all -Link student work, in partial or completed form, to the course site, for use as examples and study material for self-study as for demonstration and comment during lectures
Problems in relating group activities and product outcomes to conceptual aspects of the course, to study materials, and to individual assessment in examinations	-Use comparisons of group products, relative to conceptual issues in the course, as question on the examination; link criteria for on-going self-evaluation of group products to study materials and lecture notes also embedded in the course site

As students become immersed in the details of project work, and particularly when students are working without an instructor or support person present (as in the ISM-1 course), or are working with groupmates in another country (as in the AIT course), a particularly important issue is keeping a sense of overall cohesion and integration in the course. Partly this is administrative; students working at different times and places must have access to the common set of materials relevant to the course and project. Partly this is conceptual; students working on their own are likely to become so engrossed in the project tasks and the technology to carry out those tasks, that the link between a day's events and the theory of the course may seem very weak.

In both ISM-1 and AIT, Web environments are used which integrate all aspects of the courses, both technically and conceptually. The same environment is available for all students, both the Dutch and Finnish students in the AIT course and the full-time and part-time students in the ISM-1 course, to assure the same basic information is always available to all, as long as an Internet connection is available. The environments can be seen at

http://www.to.utwente.nl/ism/ism1-96/home.htm, for ISM-1,
and at http://wwwedu.cs.utwente.nl/~aitnlpbg/ for AIT.

The home page of each course introduces a navigation frame, stable throughout the course sites, from which all components of the course can be reached. In addition to home page links and a button relating to "news" of the week, each course offers a suite of links to different components of the overall sites: For both courses, the integrated environment includes links to areas that contain practical information for the courses: planning, time schedules, goals and phases; areas that contain resources materials for the courses, in terms of collections of external links, materials made specifically for the courses, and materials made by the students themselves; areas that support communication among all in the courses and areas that support the group activities directly. The courses differ in the specific ways these areas are organized and in various features available in the areas, but in general both courses emphasize an integration of theory, group, and organizational information.

The ISM-1 course includes all the study materials for the course. (In the AIT course, one also needs a regular textbook.) Thus while both courses use the Web sites to make a convenient and integrated set of resources available to the students whenever or wherever they are working, the ISM-1 site also can add explicit links between group-activity instructions and

the study materials in the course. Figure 1 shows a portion of one of the weekly assignments posted for the ISM-1 course (linked from the clickable agenda that serves as the "Week-by-Week" organizational-overview component of the site). Here, as the students read about their tasks for the week, they are not only told that their activities relate to the study materials of the week (which are summarized in what are called "Design Guidelines"), but they have two sets of hyperlinks provided. One set takes them directly to their group areas so they can get to work, but the other set offers the visual reminder as well as easy opportunity to go back to the theoretical materials and review these before going into the group work. To make this linkage even more explicit, it can be seen that the Design Guidelines are only mentioned in the assignment page by numbers; the student MUST go back to the study materials to refresh his or her memory of what those numbers stand for.

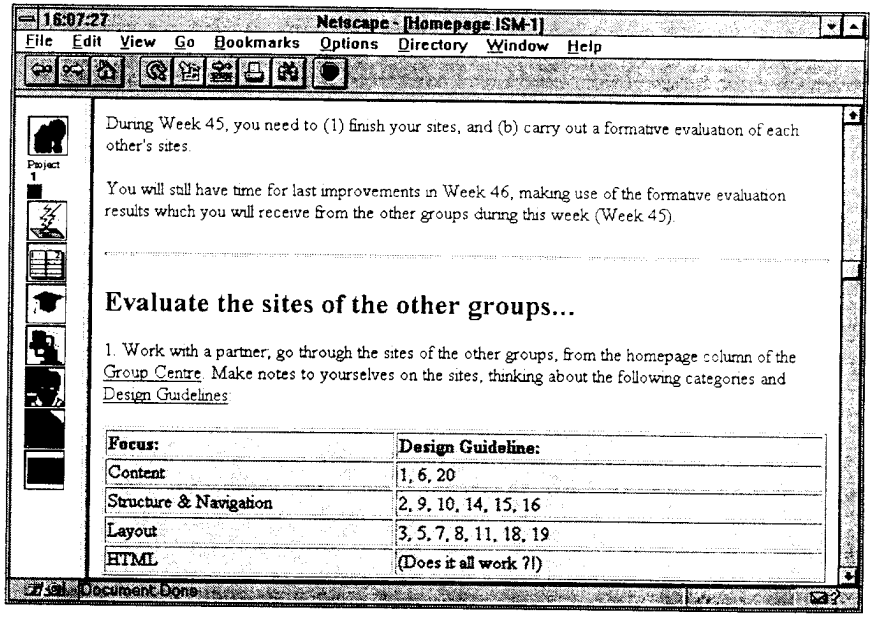

Figure 1. Relating study materials and group activities, via an assignment page, all integrated in the course site for ISM-1

Problems in Supporting Collaborative Learning

The second row in Table 1 indicates that collaborative learning is no automatic occurrence, even given the fact that some number of students are placed in a group and given a common task. The row indicated:

Problems in motivating and structuring collaboration	-Choose a task where the common product is motivating in itself; where a team approach is needed to handle the various aspects of the task; and where an instructional strategy such as the Jigsaw Methodology, whereby each group member has clearly defined and separate contributions to the group (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), is built into course requirements

When groups work without direct supervision, and when members of a group themselves may work at different times and from different locations, the problem of maintaining a balance in the efforts of each student is a serious one. This is serious, because when a group is disfunctional—when students must carry out the work of others and students do not work positively and cooperatively with each other—then the quality of the learning experience rapidly declines. Also, in such cases, the likelihood of the group finishing successfully and on time becomes low. This is also a concern for the instructor, who wishes all students to learn and to earn the grade given to the group as a whole.

A major way in which both the courses ISM-1 and AIT address these problems relating to collaboration is through the use of the so-called Jigsaw Method, where each student has a well-defined task and the skills to carry out that task, so that others in the group cannot easily fill in his or her place. In both courses, these roles are called “specialisms,” and components of the course sites, called the specialist centres, not only clarify the tasks of the specialists, but support the specialists from each of the groups to help each other in a variety of ways such as newsgroup-type discussions or contributions to additional support materials entered by the specialists themselves through common gateway interface (CGI) forms and linked to the Specialist Centre home page. Figure 2 shows this page for the AIT course.

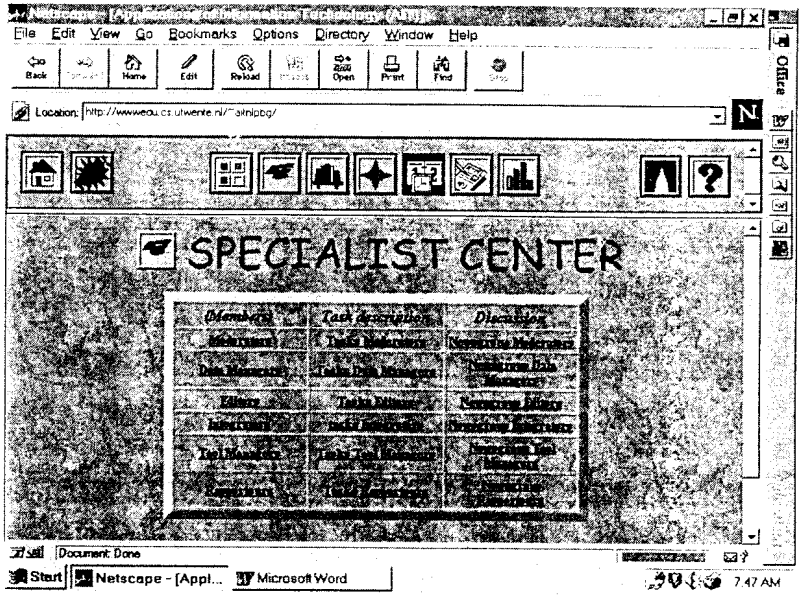

Figure 2. The Specialist Centre for the AIT course

And not only are the roles and tasks of the specialists well defined, it is also made very clear what responsibilities each specialist has within his or her own group. Figure 3 shows the group planning page for one of the groups in the course ISM-1, where not only all tasks of the group are identified, but the specialists within the groups responsible for each task are clearly noted. These specialists are responsible for carrying out their tasks and reporting or delivering the results to their group by a certain day. Certain of these results are then directly linked to the group planning page, so that the whole group can make use of them, and the next task can proceed from them.

In Figure 3, as an example, it is clear that the final set of images, taken with digital cameras and then edited for effects using image-editing software, were the responsibility of the two "image specialists" in each group who, by a certain date, linked this set to the cell "final images," so the next steps of production could occur. Only the image specialists had access to the digital cameras and had the opportunity to learn how to handle special effects with a commercial image-editing software package; thus the Jigsaw Method made collaboration essential within the group. This strategy is

related to the idea of creating and maintaining a "group memory" for a group, one of the problems identified in Table 1:

Problems in maintaining a "group memory"	-Use tools with shared workspace functionalities integrated in the course Web site so that a common view of notes, partial products and other project-management related information are available to all

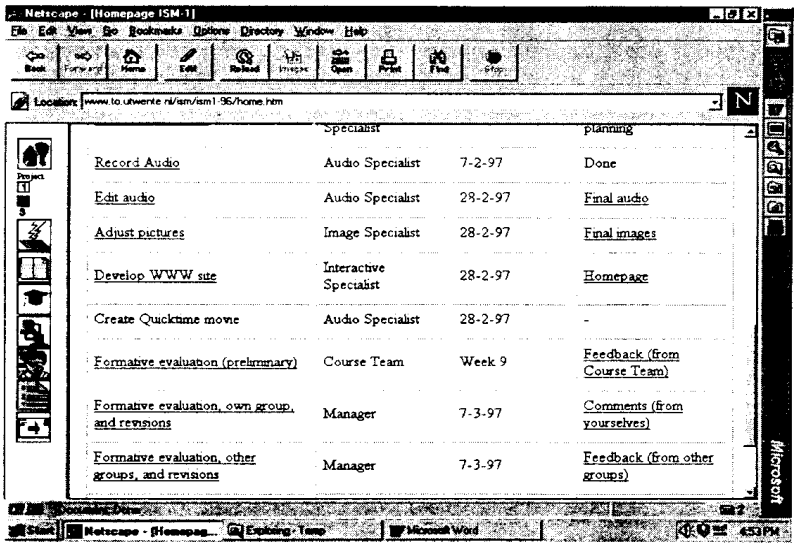

Figure 3. Portion of a group planning page, for the course ISM-1, showing links to instructions and accompanying CGI-based reporting form about subtasks, group members with final responsibility for subtask, date due of subtask, and links to deliverables from the subtasks. Each group has a similar page, linked to the course site via the Group Centre (see Figure 8).

The AIT course had previously used a shared workspace tool instead of the matrix-based group planning pages of ISM-1 in order to help students order and conveniently build their group's "common memory" or archive. The tool used is called BSCW (basic support for collaborative work), developed by the GMD (German National Research Centre for Computer Science) in Bonn, Germany (GMD, 1996). This tool is a Web-based environment in which each group of students can store and manage various kinds of documents, such as texts, images, hypertexts, audio, and video. The files can be named, grouped, visualized, and annotated in a large variety

of ways. BSCW keeps track of the events that take place in the workspaces, such as adding, reading, and updating documents, and of the individuals involved in those events. Features such as version management and file locking are also available. Figure 4 shows a user view of a shared workspace, showing some of the icons available to indicate forms of action that have been taken on common resources, the "i" tool to allow group members to add comments to any of the folders and files, to label folders and files descriptively, and allow direct links to materials for immediate access in the Web environment.

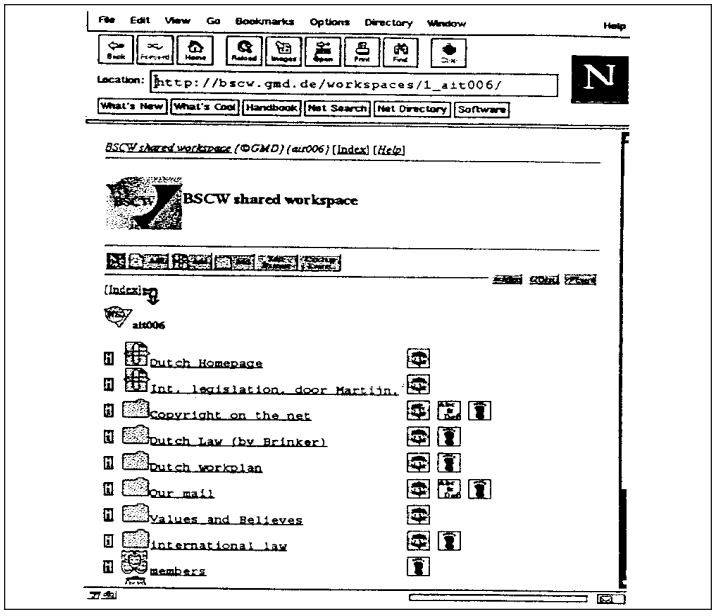

Figure 4. The BSCW shared workspace tool to facilitate group collaboration and archiving, as used in the AIT course

In the 1997 run of the AIT course the BSCW has been replaced by a newsgroup-like system for group memory. Because BSCW is designed for collaborative document processing and in AIT the documents are mostly written by individuals (and the documents are part of the group product), BSCW is too heavy a tool. It was not being used properly in the AIT course. Similarly, in the ISM-1 course, the BSCW tool is not used (although it is in other courses in the Faculty of Educational Science and Technology) because the common access that students have to areas on the server and the communication possibilities they have within the Web environment to embed comments directly in pages to which they have common access, have made the BSCW tool somewhat redundant. However, it

remains a powerful tool for courses whose activities match its functionalities and do not have other tools available that are a closer fit.

Problems in Motivating and Structuring Communication

Communication is critical within group-based project learning. There are many forms and directions of communication: among the group members in an informal way; among specific group members (such as between the image specialists in the example shown in Figure 3); between the groups, such as among all the students sharing a certain specialist role (see Figure 2 for the way newsgroup links are used for this kind of communication in the AIT course); communication from the instructor to the groups or to certain persons within the groups (those with a certain role or a particular student as an individual); and communication from the groups to the instructor. The third row of Table 1 indicated some of the ways in which communication is being supported in the ISM-1 and AIT course sites:

Problems in motivating and structuring communication	-Develop a strategy of having a manager in each group responsible for reporting group progress and group reflection, via embedded email, newsgroups, CGI forms, and other tools, available in the course Web site, and with results of this input linked into the course site so that a group archive is built from the communication

Both courses have convenient areas for communication support. The ISM-1 course site has a Communication Centre, where not only persons with specific roles can be directly emailed, but also each student is listed individually, by group, to facilitate interpersonal contact between any two persons in the course, students or instructors. Figure 5 shows the Group Centre home page for the AIT course, in which communication with the Dutch and Finnish instructors for each group is facilitated, as well as a common discussion tool for the members of each group.

In the ISM-1 site, considerable use is made of CGI forms for structured communication. Through the size and designations of the fields in the form, students have a clear sense of what input is expected of them, and how much. All CGI forms are integrated in the course site, so entering communication input is easy. Sometimes this communication is linked within the study materials; sometimes it is a method to carry out or report on the group activities for a certain week. For example, Figure 6 shows a very structured form used for peer evaluation (where each group evaluates each other group's products while they are still in construction, in order to provide formative evaluation that can be used to further improve

the products). When these forms are submitted, they are posted in various ways; for example, peer evaluation is linked to the group planning page for the group to whom it is intended, so that everyone in the group, and the instructor, can easily see the feedback that has come from other groups. (The CGI forms for peer evaluation also include open-response fields, so more general comments and suggestions can be sent). The latter is an example of what is called "productive communication" via the Web site: communication is not only for discussion, but also for more specific task-related comments.

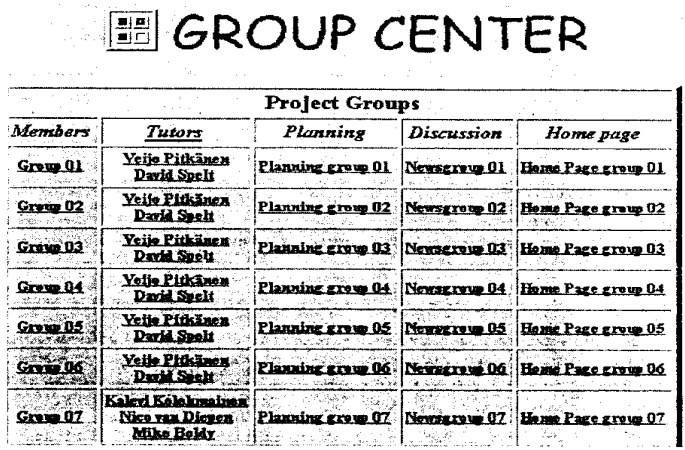

Figure 5. The Group Centre for the AIT course, facilitating communication within and between groups

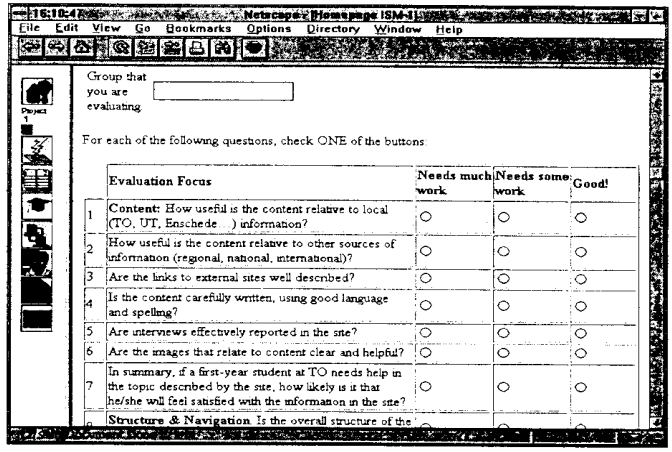

Figure 6. An example of highly structured communication via CGI forms for task-related purposes between groups in the ISM-1 course

This aspect of communication—to serve as constructive feedback within and among the groups—also relates to another row of Table 1:

Problems in organizing and executing self- and intergroup evaluation	-Use the course Web site as the product as well as the process environment, so that partial and final products are available for self- group, peer and instructor evaluation, using structured evaluation instruments (CGI forms) also integrated into the course site; post and use these various forms of evaluation as basis for final evaluation of the group product (Collis & Meeuwsen, 1997)

Both the ISM-1 and AIT course use tools of various sorts to embed opportunities for structured communication within their sites, as well as different strategies and tools for displaying those communications within the sites. Structured communication is becoming a major way of developing skills and habits of self-evaluation for the ISM-1 students in particular (Collis & Meeuwsen, 1997).

In the AIT course, there is also attention given to real-time communication, believed to be particularly useful to develop a sense of group rapport among the Dutch and Finnish students in each group who have no other opportunity for any real-time interaction. IRC (chat) functions are available via the course Web site, and also, outside of the Web site, several videoconferencing sessions have been carried out. The part-time students in the ISM-1 course have also had the opportunity to use desktop videoconferencing systems in their own homes in order to interact with their group mates and the instructors. In each of these cases, however, the videoconferencing is still at the experimental stage, both technically and in terms of strategies and social skills. In the AIT course, the use of real-time communication is becoming more important to the support of the group process among the distributed students the more its potential is explored.

Integrating Process and Product

All of the rows in Table 1 relate to a major aspect of group-based project work in higher education: a focus on both the product of the group collaboration and the process of the group collaboration. In both ISM-1 and AIT, a central benefit of the integrated Web aspects of the course is that support for and access to student work can be linked to the process that creates the work, as well as to the conceptual aspects of the course.

Figure 7 shows the Product Centre for the AIT course, and Figure 8 shows the Group Centre home page for the second project of the ISM-1 course. All group products are available, as well as resource materials relating to those products. In the ISM-1 example, the final feedback from the instructors is also linked. The products for AIT consist primarily of collaboratively produced writing, but possibly containing graphics, audio, and video as well. The products for ISM-1 are Quicktime movies and Web sites that include embedded Quicktime movies, audio files, images, and animations made with JavaScript, as well as five sets of question-answer-feedback pages, all made with JavaScript. Without the functionalities of the Web environment, these final products have not before been able to be integrated into a common environment, accessible to the students for study and interest, and accessible to the instructors from wherever they have Internet access for further evaluation and use in subsequent courses.

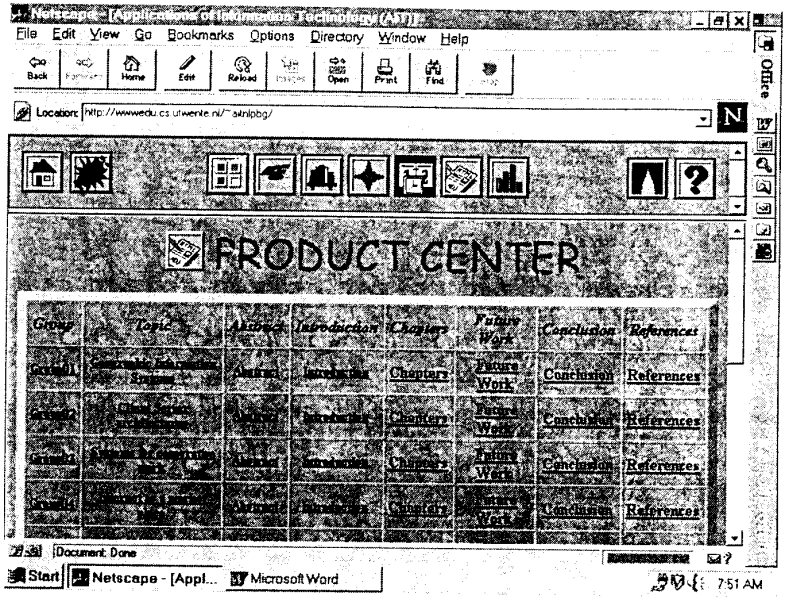

Figure 7. The Product Centre for the AIT course

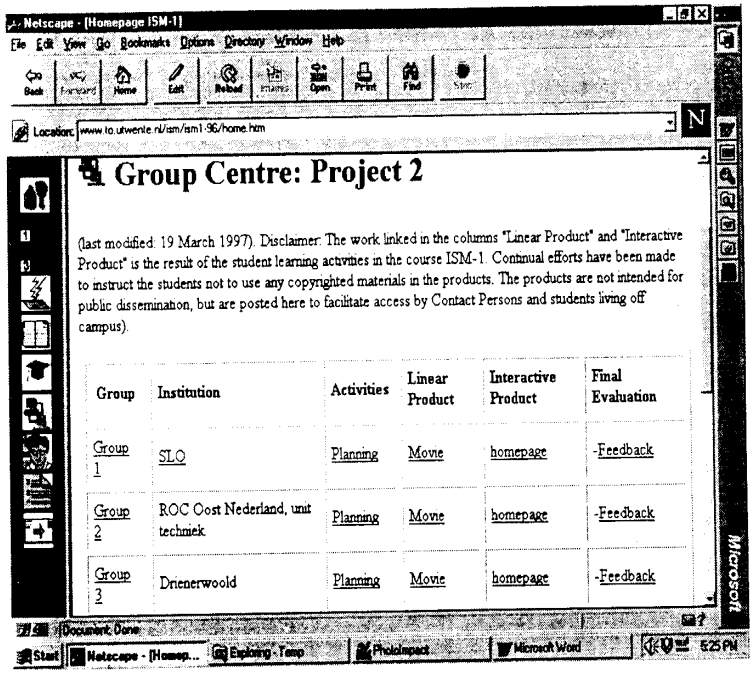

Figure 8. The Group Centre for the ISM-1 page, linking to the multimedia final products and to the instructor evaluation

CONCLUSION: SOLVING SOME PROBLEMS, BUT MOVING FORWARD WITH OTHERS

Although the courses have been positively evaluated by their students and instructors (Bos, Morgan, & Kikstra, 1996; Collis, 1996a; Collis & Breman, 1997; Van Diepen & Pouw, 1995; Joosten, Andernach, & Van Diepen, 1995; Pouw, Terlouw, Joosten, & Van Diepen, 1995; also see the AIT Web sites themselves), they highlight on-going problems as well as satisfactions in the use of group-based project work as an educational strategy. (For the 1996 AIT course, see http://wwwseti.cs.utwente.nl/~andernac/AIT/Evaluation/AIT96/formresults.html, and for the 1997 AIT course, see http://wwwseti.cs.utwente.nl/~andernac/AIT/Evaluation/results97.html). We indicate some of the major satisfactions and some of the major problems in this section.

Satisfactions

The efficiency of the Web-integrated sites brings project work to a much more manageable level, for both students and instructors, and it facilitates, or perhaps even makes possible, groups whose members can work asynchronously in time and from various locations. The instructor also has flexibility in the time and place of observing what the groups are doing and intervening or otherwise giving feedback. Perhaps the major satisfaction is being able to see each other's products, as they develop and when they are finished, from a common and convenient interface, the same as the rest of the course. The Jigsaw Method of individual responsibility based on well-defined tasks and specialisms, seems to be a core instructional strategy. Basing part of the course mark on process performance, as indicated by submissions, on time and of an acceptable quality, into the Web site, also is an instructional strategy with younger students at least, to maintain overall tempo. Having a final presentation on a set date, and then basing individual examination items on critical reflections of the final products of one's own group as well as those of other groups, appear to be effective strategies to keep the momentum of the learning experience consistent across the groups and within them.

And Attention Points

Despite the satisfactions, at least four areas of attention are of particular interest:

- Which project-management tools can be most effectively integrated into Web environments for group-based project work for students and for instructors? What differentiates these tools, for use in a learning context, from project management tools available as part of more generic groupware suites (Van der Veen & Collis, 1997)?
- How can students, accessing a course Web site at different times for study or for project-work activities, be most effectively helped to see the relationships between theory and practice in the course? Can this help be scaffolded, so that more is available to certain learners while less or different support is available to others? When is a brief linear presentation, such as a fragment from a previous lecture or a segment of an interview with an expert, going to be effective as an embedded learning aid? When will interactive help resources, such as familiar hyperlinked text-based help files, be more effective? What theory can guide us in making these decisions (Collis & Verhagen, 1996)?

- What do students most value in Web sites for course support? In our research so far, which is only preliminary, we have found students to be more interested in efficiency than enrichment, but a much broader sample of courses and students is needed before our model predicting the impact of telematics-applications on student performance can be considered tested (Van de Kamp, Collis, & Moonen, 1997).
- When students are geographically at a distance from each other, when and how can real-time communication be integrated with a Web-based support environment (Van der Veen, 1997)? When this distance also involves cultural differences, what are the basic needs that must be met in order to set up successful collaborative project work?

Thus, what seems to be a simple question: *How can the Web be used as a learning tool for project work?*, is actually very complex.

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