Hyperdisciplinary Courseware:
A Means of Integrating the Curriculum

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Abstract[1]

This paper will discuss the development of hyperdisciplinary courseware: World-Wide Web (WWW)-based, tightly coupled, interdisciplinary courseware. It will also discuss the tools required to create hyperdisciplinary courseware, a ongoing effort at the United States Military Academy and other institutions to create hyperdisciplinary courseware, and the perceived advantages and disadvantages of the courseware. WWW-based hypermedia has the potential of interconnecting related courseware from different courses or different institutions in ways that were previously impossible. This provides for the explicit development of threads of learning, independent of departmental boundaries, within an institutional and potentially for seamless integration of course material across institutional boundaries. This is a fundamental and powerful change in how students learn. Previously, students completed a series of often loosely coupled courses that comprised the student's undergraduate education. Synthesis of these different courses and course material was left as an exercise for the student. Hyperdisciplinary courseware solves this problem by tightly coupling courses in an orthogonal network-based framework. WWW-based hypermedia, with the development of the proper tools, could facilitate the development, coordination, and presentation of information across departmental boundaries. This will fundamentally change how students prepare and review course material outside of the classroom.

The Problem

Over the last three years, thousands of hypermedia courses based on the World Wide Web (WWW) have been developed. This hypermedia courseware ranges from simple text to interactive, adaptive hypermedia courseware. At the United States Military Academy, hypermedia courseware development focused on a single pilot program, CS383 [see 1-7 and Figure 1]. Begun in 1993, this program was highly successful and based on its success and the popularity of the WWW, hypermedia courseware spread throughout the Academy. As different departments began to develop hypermedia courseware, fundamentally different interface designs, directory structures, and courseware functionality were used. Moreover, different departments developed different tools that provided the same functionality (assessment, learning styles assessment, etc.). This wasted courseware development time and confused students as they had to learn different course interfaces that provided basically the same functionality. Finally, attempts to integrate the hyper-
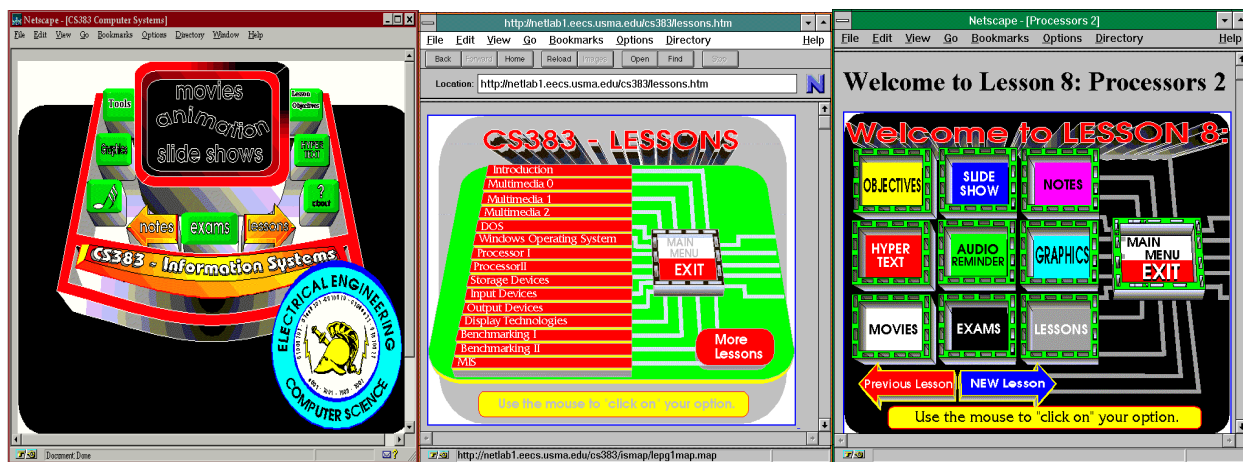

Figure 1: The User Interface into Hypermedia CS383: Course Homepage, Lesson Selection Page 1, and Lesson Page

media courseware from different courses across departmental boundaries were difficult and often required significant recoding of the divergent courseware. What was needed was hyperdisciplinary courseware - hypermedia courseware that was interdisciplinary and tightly coupled that was easy to use and develop. This paper addresses efforts to develop such a system and the advantages and disadvantages associated with such a system.

Hyperdisciplinary Courseware

Introduction

WWW-based hypermedia has the potential of interconnecting related courseware from different courses or different institutions in ways that were previously impossible. This provides for the explicit development of threads of learning, independent of departmental boundaries, within an institutional and potentially for seamless integration of course material across institutional boundaries.

This is a fundamental and powerful change in how students learn. Previously, students completed a series of generally loosely coupled courses that comprised the student's undergraduate education. Synthesis of these different courses and course material was left as an exercise for the student. Coordination between different courseware was haphazard at best and often contained obsolete links. With hyperdisciplinary courseware, the interconnections between courses are explicit in the form of links and coordinated so that departmental or institutional boundaries are transparent to student. The students does not know or care what department is providing the information; the student is solving a problem that requires informational resources which are being provided over the WWW. For example, students currently learn cross products in math and then relearning it again in a slightly different format in physics, chemistry, and civil engineering. With hyperdisciplinary courses, students would learn cross products in math and then have links to other courses that use cross products so that students could clearly see where they would use cross products. Once the students start the application courses (chemistry, physics, mechanics, etc.), they can use the links back to the hyperdisciplinary math course to refresh their knowledge

Figure 2: Course Creator Course and Lesson Interface

of cross products. Instructors in all courses using cross products could see in minute detail how other courses were using cross products.

Because this hyperdisciplinary approach yields a curricula-wide view, institutional administrators and deans can identify and reinforce threads of learning to provide a consistent and integrated curriculum. WWW-based hypermedia, with the development of the proper tools, could facilitate the development, coordination, and presentation of course material across departmental boundaries.

Software Tools

The software tools needed for the development, coordination, and presentation of hyperdisciplinary courseware are already being developed. The HTML Course Creator, HTML Glossary Tool, Adaptive Student Response System, Course Digital Library and Adaptive Hypermedia Interface are examples of tools developed to support the development of hyperdisciplinary courseware at the United States Military Academy [4-6, 8]. The HTML Course Creator provides a point and click interface for the rapid development of hypermedia courses [See Figure 2]. Courseware development using the HTML Course Creators requires no knowledge of HTML and provides a consistent and easy to use tool specifically designed for courseware development. It also builds a consistent directory structure between courses so that similar resources are stored in similar locations. This greatly facilitates interlinking courseware and sharing resources across departmental boundaries. Other institutions have likewise build similar tools to standardize courseware development [see 13-20 for similar projects].

The HTML Glossary Tool recursively searches through course hypertext and adds glossary term pop-up definitions from a common dictionary. Multiple dictionaries can be applied to the same hypertext. This facilitates the development, maintenance, and sharing of course dictionaries across course boundaries. No longer does every occurrence of a term need to be individually annotated or be revised if the definition changes. This facilitates the development of large and consistent course hypermedia.
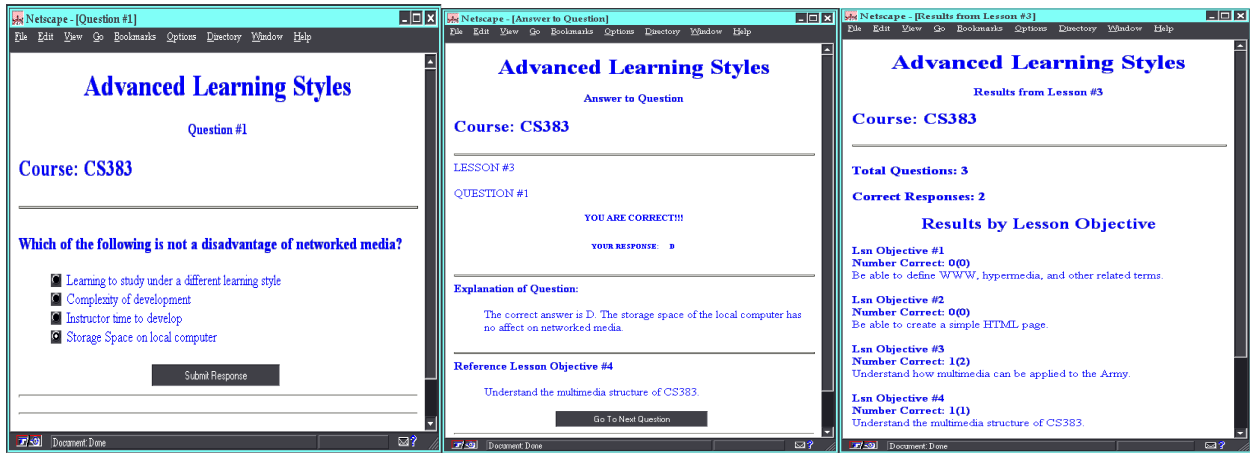
Figure 3: The Student Response System - Answering a Multiple Choice Question, Feedback on the Same Question, and Feedback at the End of the Lesson

The Adaptive Student Response System provides an online testing tool that adapts the difficulty of the question based on how the student has answered previous questions [4]. It supports multiple course thus providing a single online assessment tool for hyperdisciplinary courseware [See Figure 3]. If the students is answering correctly, the student gets harder questions while if the student is answering questions incorrectly, they receive easier questions. Both instructors and students receive feedback on student performance using the system. Student feedback color-codes lessons objectives so that the student can prioritize future study. Hypermedia-based hints including sound, video, text, and graphics facilitate student review of course material. Instructor feedback includes summaries, by section, of lesson objectives by section performance. By providing a single tool for assessment across course boundaries, the adaptive student response system supports hyperdisciplinary courseware development.

The course digital library allows for the anonymous paperless submission and grading of student papers and presentations and support for a digital library of previous student submissions [6]. Students can search and use these previous student submissions to build their papers and presentations. Furthermore, students are no longer bound by the limitations of paper and can submit papers and presentations with audio, graphics, digital movies and other media to support their submissions. Student submissions are no longer a one-time submissions but instead become a permanent addition to the informational resources of the course. By interlinking different course digital libraries, courses can share student-generated information across course boundaries and reinforce student learning.

Finally, the adaptive hypermedia interface adapts the interface of the course according to the learning style of the individual student [5]. Each student gets a different interface into the course based on their learning style [See Figure 4]. The adaptation is based on Felder's Learning Style Model and Soloman Learning Style Assessment [9-12]. As the size of the courseware grows, the importance of an adaptive interface likewise grows. As reported in [2], as many as 25% of a course's students are unable to effectively use large hypermedia-based courseware that has multiple, equally valid approaches to the course material. Hyperdisciplinary courseware only increases this problem of hyperspace disorientation and student focus. The adaptive hypermedia courseware addresses the needs of these students by structuring the courseware according to each
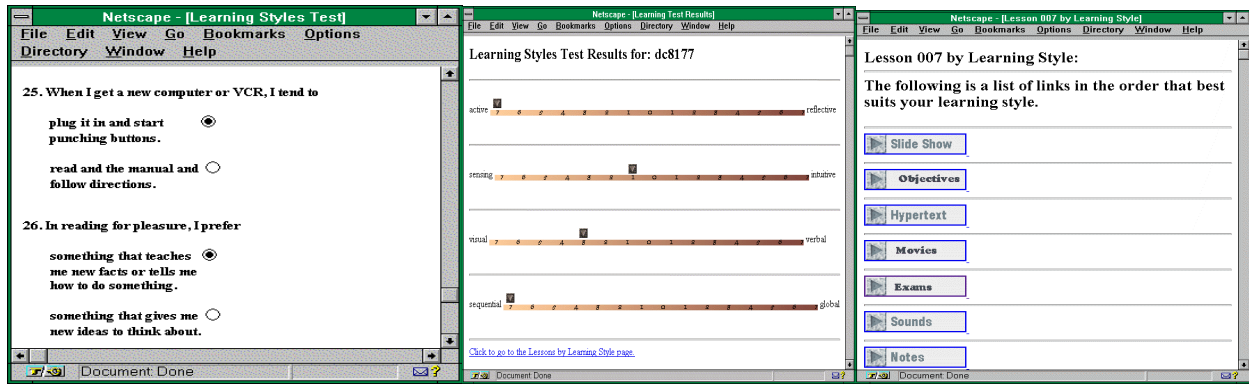
Figure 4: Some Questions from the Learning Style Assessment, the Results of the Assessment, and the Dynamic Sorting of Media Based on Learning Style

student's unique learning style. This intelligent tailoring of interface to the student will be vital to hyperdisciplinary courseware development.

Potential Problems

While the promise of hyperdisciplinary courseware is extraordinary, the technical and political problems are considerable and tremendous work remains to be done. The tools mentioned above facilitate the development and presentation of hyperdisciplinary courseware. Additional tools are necessary, however, to support the coordination of the development of the courseware necessary to build hyperdisciplinary courseware. Should this coordination be done at the course level, lesson level, or lesson objective level? Should the coordination be centralized through departments or decentralized at the instructor level? What mechanism will be used to provide persistent uniform resource locations so that as courses migrate within a department, courseware links from other courses remain accurate? Furthermore, as of yet, no large-scale hyperdisciplinary courseware has been developed although the initial coordination between departments has been made which has lead to an NSF proposal. Coordination between the United States Military Academy, Virginia Tech, and the University of Wales is also underway to extend the idea of hyperdisciplinary courseware to apply to different institutions and measure the effectiveness of hypermedia-based courseware. As this courseware is developed, additional problems previously unseen will arise.

In addition to the technical difficulties associated with developing hyperdisciplinary courseware, considerable political barriers remain. Hyperdisciplinary courseware clearly and explicitly displays threads of education between different department which may or may not be desired. Course boundaries are weakened as interconnected courseware treats courses as informational resources in an integrated educational system. This will weaken the flexibility and discretion of course directors and strengthen the power of department heads and administrators. Individual professors will have less opportunity to develop their own courses without external input or teach the same course that they have taught for the last twenty years. Interrelationships between different courses will become clear and perhaps more importantly, interrelationships that where thought to exist between courses and in fact do not will also become clear. Courses that previously had been considered "vital" to a curriculum may not be and instead may be viewed as iso-

lated "towers of knowledge" that are never revisited during undergraduate or graduate education. Professors, resistant to change, oversight, or the tremendous amount of work required to create hyperdisciplinary courseware will decry the impairment of academic freedom, lack of proof that hypermedia courseware will improve learning, and a variety of different reasons to stop or slow the development of hyperdisciplinary courseware. These political barriers are significant and will not be easily overcome.

Summary

The promise of hyperdisciplinary courseware is clear: fundamentally interdisciplinary, tightly coordinated, explicitly linked curriculum with the seamless sharing of vast amounts of information between courses within an institution. The potential for synergy and enhanced learning is likewise obvious. However, the technical and political problems that must be overcome are significant. Waiting to start converting to hyperdisciplinary courseware only acerbates these problems and increases the cost associated with the conversion.

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