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Teaching Database Development with Hypertext

ABSTRACT: This paper discusses our experiences in designing and authoring a hypertext system to guide students through a database project. The system targets instruction in three areas: developing database skills, directing analysis and design of a business's data needs and supporting construction of a database application to meet those business needs. The hypertext tool was built to conform to the standards of Microsoft's WinHelp help system architecture. Initial experiences with the system support the claim that the tool assists students in analyzing, designing and implementing database solutions.

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INTRODUCTION

Face-to-face, individualized instruction is an ideal method for introducing database design concepts, tools and their applications. Personalized instruction draws on an instructor's powers of observation to create specialized approaches to student skill acquisition. Instructors can customize communications to help a student better apply database tools to business problems; however, time and resource constraints may limit opportunities for individualized instruction.

A hypertext system, while not a substitute for personalized instruction, offers an opportunity to allow students to organize and individually explore task related instruction. A hypertext system presents information and allows students to follow graphical or text based links to drill down to specific details. Hypertext offers students a high degree of freedom to explore information and to create a customized approach to learning.

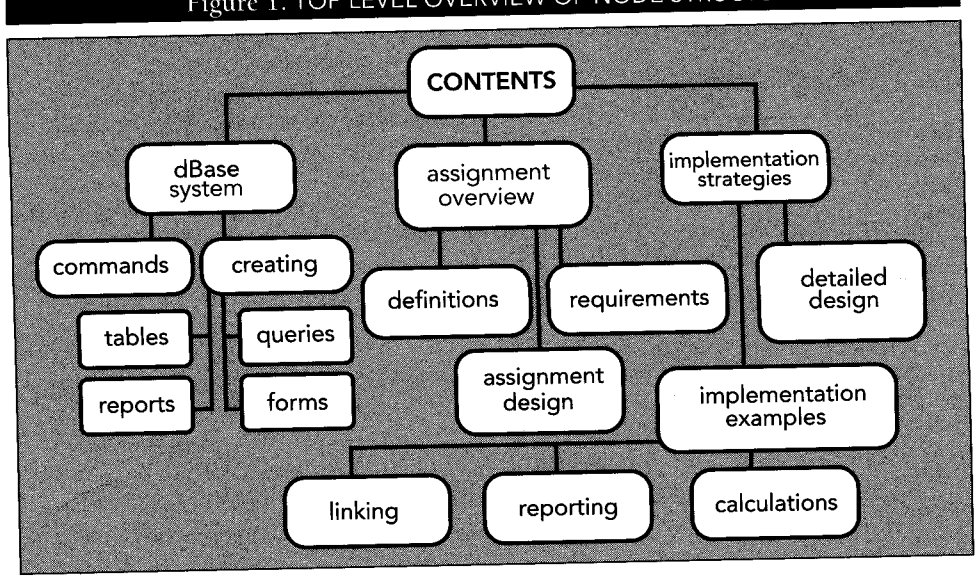
This paper presents a hypertext teaching tool targeted toward junior level business students. The system guides students through the analysis and design of a business's data needs. It also provides information on database tools required for meeting those needs. The system supplements traditional instruction by integrating topics such as computer concepts, systems methodologies, and database development.

This paper describes an instructional application of Microsoft's WinHelp hypertext authoring software. The following presents our experiences in designing and authoring the hypertext system and examines students' impressions. Hypertext applications in education and training are growing and the next section discusses some recent hypertext trends. The system's design and authoring tools are then discussed, followed by students' evaluations.

HYPERTEXT TRENDS

Hypertext mimics the human mind's ability to associate and quickly access information (1). Users click on link icons to navigate through networks of nodes that usually have a one-to-one correspondence with "windows" displayed on a screen.

Figure 1. TOP LEVEL OVERVIEW OF NODE STRUCTURE



Nodes may contain, along with graphics and text, multimedia information including sound, video, and animation.

Hypertext systems provide readers with the ability to browse networks in a non-linear manner where hypertext "jumps" may lead to distant nodes. Readers of hypertext systems can easily become disoriented or "lost in hyperspace" but visual cues can help orient and direct users (2).

Well-designed hypertext reduces navigation complexity and increases flexibility in retrieving information. Navigation aids include displays of multiple windows, local and global graphical system maps, trail markers, and backtracking components. In addition, users may annotate visited notes and quickly locate relevant information through system indexes (3,4).

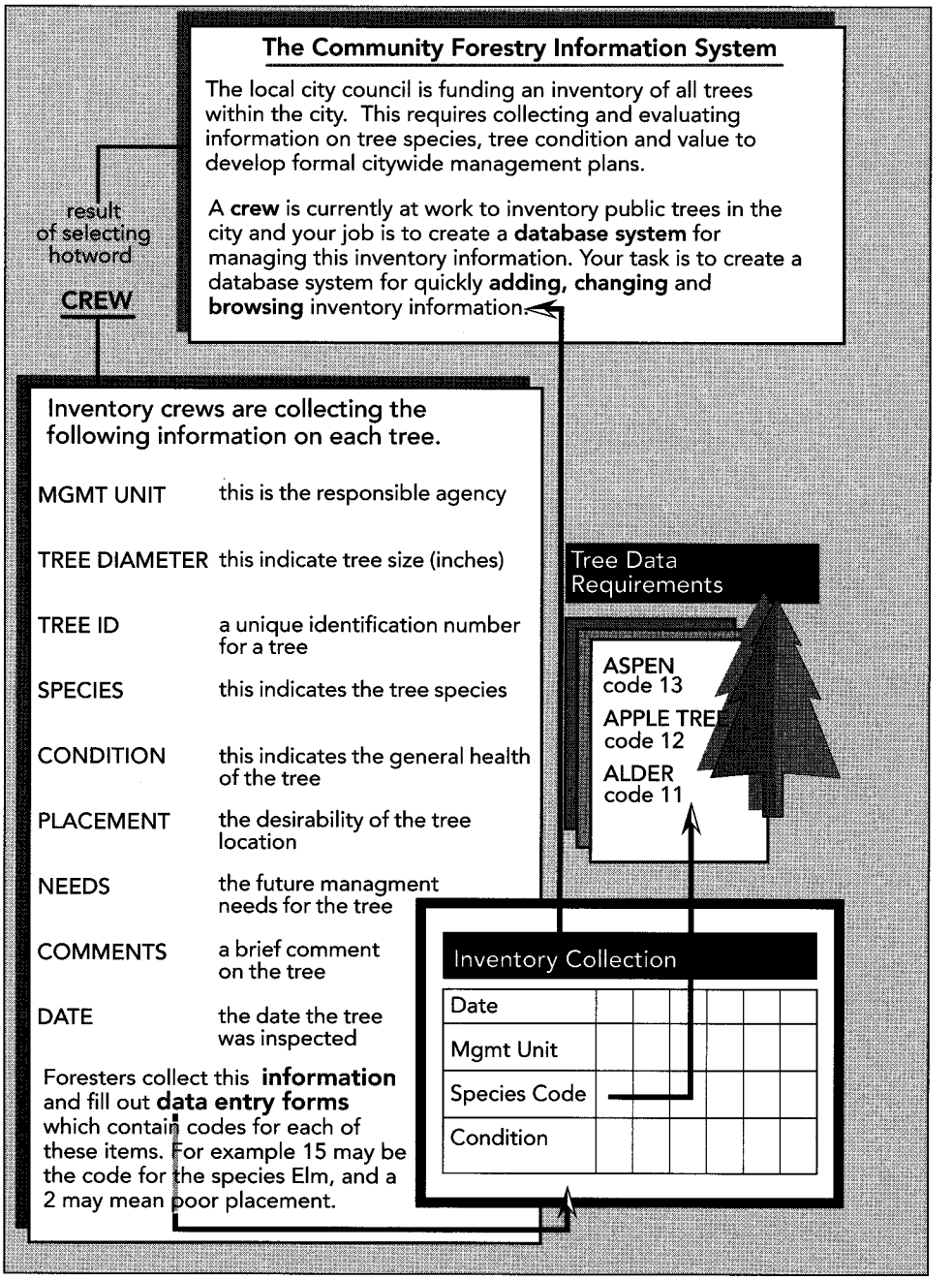
There is a growing interest in applying hypertext in education and training. Researchers report hypertext courseware improves student performance and promotes collaborative learning (5,6). Others have noted difficulties in designing usable hypertext and report hypertext does not support higher-level learning (7,8). Hammond (9) suggests that hypertext is beneficial when it supports a specific task.

Providing students with information flexibility, rich navigational aids, and guidance in application development introduces challenges to hypertext authors. Designers of hypertext teaching tools must consider approaches that encourage consistency, improve communication among multiple authors, promote reusability, and provide mechanisms for extensions. Current hypertext design methodologies incorporate aspects of object-oriented, semantic and entity modeling (10).

Hypertext authors require tools that provide an easy way to create and edit multimedia nodes, define links and support a range of strategies for assisting reader navigation. MacKnight and Balagopalan (11) present a comprehensive list of tasks required of authoring tools and suggest a model for comparing authoring systems.

Currently there is no agreement on standards for development of hypertext systems. Yet software developers for major Windows applications provide on-line hypertext documentation through Microsoft's WinHelp help system architecture. Once students learn the "look and feel" of WinHelp they can easily navigate on-line documentation in other Windows applications. The WinHelp architecture provides hypertext authors with a well documented, extensible and maintainable environment and the ability to create stand alone systems (12).

Figure 2. EXAMPLES OF NODES AND LINKS DESCRIBING ANALYSIS REQUIREMENTS



This study concerns design and testing of a hypertext system that conforms to WinHelp and runs in the Window 3.1 environment. The following presents an overview of the design and implementation of the system.

SYSTEM OVERVIEW AND REQUIREMENTS

The hypertext system assists students in exploring a business problem and guides students through steps for constructing a database application to address that problem. Students navigate through the system's information by following links, accessing indexes and key words, and backtracking as needed to previous topics. The system includes pop-up windows, graphics, and hot links with the ability to jump from one topic to another.

The system contains three major subsystems. The database tutorial subsystem

Figure 3. STUDENTS CLICK ON AN ENTITY OR A RELATIONSHIP TO OBTAIN A DETAILED DESCRIPTION

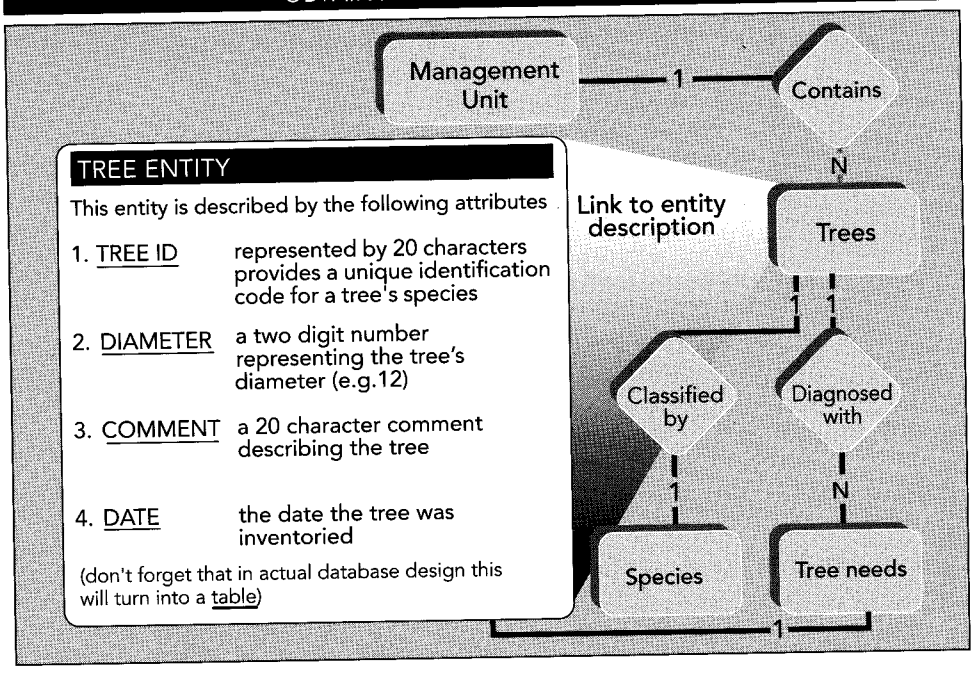
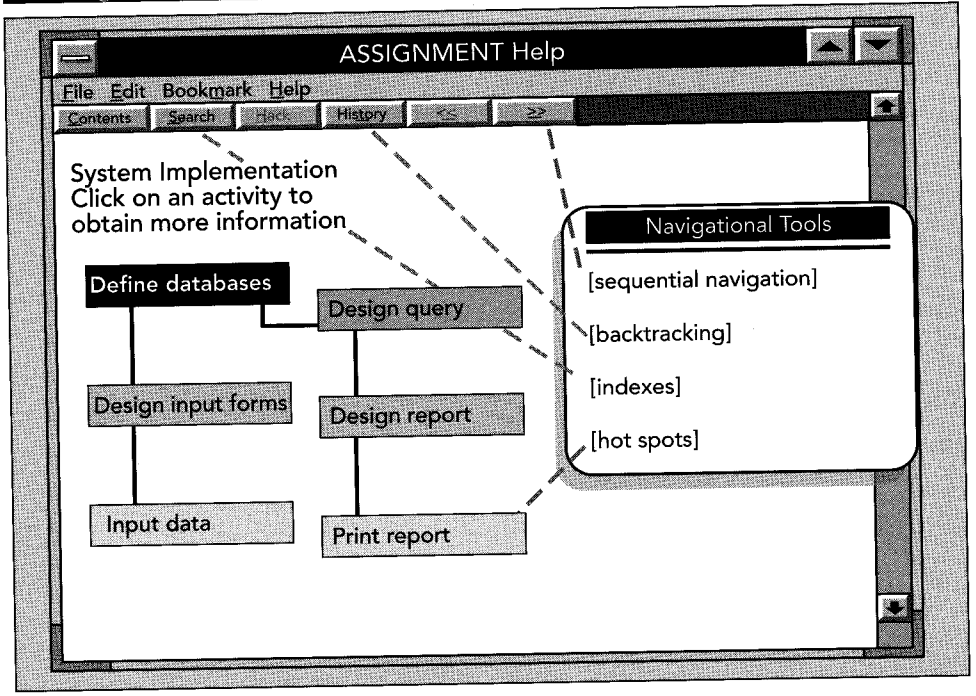


Figure 4. A NODE DEMONSTRATING STUDENT NAVIGATION OPTIONS



provides an introduction to the dBase IV database environment, including how-to instructions for creating tables, queries, and reports. The analysis and design subsystem presents a business case and provides background information for understanding and analyzing management's information needs. The implementation subsystem provides specific instructions for constructing databases, queries, and reports to address the business case information requirements.

Hypertext System Design

Design of the hypertext system consisted of first developing a backbone model of nodes and their associated links. Figure 1 presents an overview of the design structure of top level nodes. Design proceeded by specifying and extending top level nodes to create additional node layers. The final system contained seventy-five nodes. Structural links provided access across subsystems and specified hierarchical relationships among nodes.

Other links fall into two categories: aggregation and association links. Aggregation links allow readers to drill down to detailed information or to obtain a different perspective on a topic. For example, aggregation links permit readers to navigate between text descriptions and graphical flowchart diagrams of a business process. Association links allow navigation to related topics. For example, association links let readers navigate between the software specific details of producing a report to business information needs supported by that report.

Figure 2 shows an example of nodes and links describing the projects analysis requirements. Figure 3 presents a hypertext node containing an entity relationship diagram where students click on an entity or relationship to drill down to detailed descriptions.

System Implementation

The implementation of the hypertext system conforms to Microsoft's WinHelp standards. The architecture allows authors to maintain and extend information within those applications specifically adapted to handling particular information types (e.g., text in word processors, graphics in paint programs, animation in animation applications).

Microsoft's help compiler links text, graphics, and navigation components to create a stand alone application. The compiled application provides students with rich navigational tools such as indexes, history files, backtracking, and annotations. Figure 4 shows a node's window and highlights reader navigational tools available in the WinHelp architecture. Figure 5 shows the result of selecting help for designing a query.

Authoring the system required about 30 hours of design and programming effort and took advantage of previously prepared text-based tutorials and student hand-outs. Graphics were created with paint programs and screen capture utilities. A hot-spot editor allowed creation of hot links within graphical images so readers could navigate by clicking parts of a graphic.

System Evaluation

An implementation of the hypertext tool was evaluated to explore the following claim:

The hypertext system will support students' learning and assist them in designing and implementing a database system to meet a business's information needs.

This claim follows from research that indicates understanding improves when information is presented in a variety of forms and at various levels of depth (9). Novices first focus on concrete examples and iteratively develop refined conceptual models as they identify and abstract information. Hypertext takes advantage of human visual skills to reduce navigation complexity and to increase flexibility in locating, retrieving and, organizing information. By providing tools to flexibly organize and retrieve a wide variety of information, hypertext encourages students to develop conceptual models that assist understanding and problem solving (1,13,14).

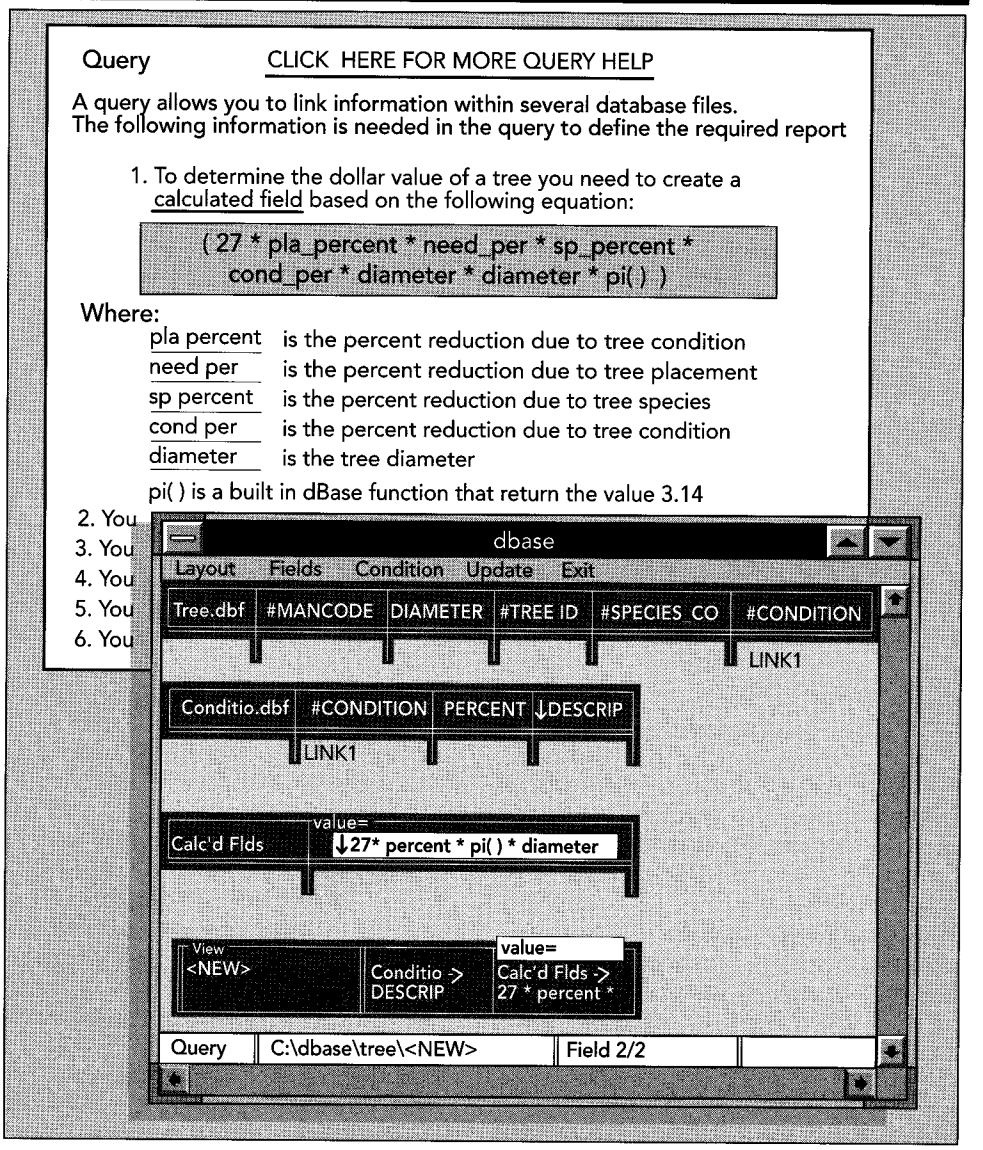
Survey Methods

Undergraduate students enrolled in an Information System course completed a database course assignment. Students had basic computer literacy but had not been exposed to database concepts or dBase IV development. The assignment required students to apply dBase IV to create a five table database, create entry forms, construct queries to link tables and prepare reports to address a business' needs. Students worked together in groups of two or three to complete the assignment. At the conclusion of the project students completed confidential group project peer evaluations to measure criteria such as effort (time spent on the project), quality of contribution, member participation, satisfaction, and peer assigned grade point allocations.

The course stresses data management as a key organizational concern. Students explore concepts and purposes of information systems as well as the relationship between information systems and organizational needs. The database assignment challenges students to integrate concepts of analysis, design and implementation. The course uses two text books. Principles of Information Systems covers material on information system concepts (15). Using dBase IV provides introductory material on dBase IV implementation (16).

As a control, one class received traditional instruction on the database assignment's requirements, design, and implementation strategies. This group was provided with class hand-outs, attended three lectures dealing specifically with the assignment,

Figure 5. STUDENTS CAN CLICK ON HOT WORDS IN THE TEXT TO ACCESS POP-UP WINDOWS THAT PROVIDE DETAILS FOR CREATING A QUERY



and participated in two 40-minute sessions of hands-on dBase IV instruction in a computer laboratory setting.

Another class was provided with the hypertext system. The instructor presented a 40-minute introduction to the use of the hypertext system. Students then relied on the system to explain their assignment, to guide them through business requirements, analysis and design, and to provide their dBase IV instruction. Students accessed the system at their convenience over a 6-week period to create a business system. Approximately 3 weeks after the due date for the assignment, we surveyed students on the criteria concerning the hypertext system's components.

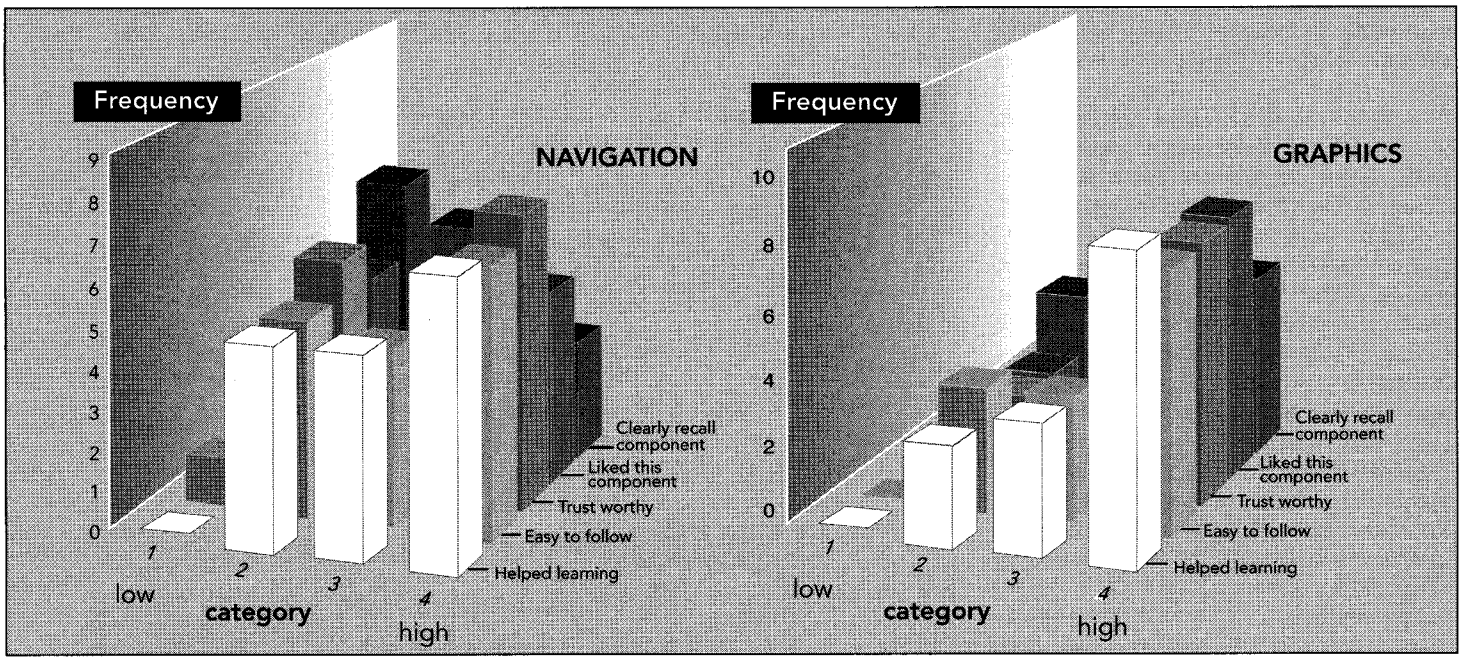
The hypertext system survey addressed the effectiveness of the following system components: navigation, backtracking, indexes, textual descriptions, graphical components, examples, color, printing, and usability. Students rated each system component according to the following evaluative criteria: a) assistance to learning, b) ease of use, c) impact or impression, d) trustworthiness and, e) whether they liked the component.

RESULTS

Treatment vs. Control Groups

Tallies of peer evaluation forms revealed hypertext-aided groups reported spending more time on the assignment than control groups who did not use the hypertext system (31 hours vs 28 hours; $p < .10$). Other measures such as quality of contri-

Figure 6. STUDENT PROFILES OF NAVIGATION AND GRAPHIC COMPONENTS BY EVALUATIVE CRITERIA.



bution, member participation, satisfaction, and peer point allocations among group members revealed no significant difference between hypertext aided and unaided groups. Students in both treatment and control groups were generally satisfied with the quality of their projects (control 87% vs. treatment 80%).

Hypertext Survey Results

In the hypertext treatment group, the most common complaint was the difficulty of working with two operating system environments: a DOS session for constructing the dBase IV application and a Windows session for accessing the Hypertext help system. Those entering the class without exposure to Windows required extra instruction and encouragement.

A clustering algorithm identified patterns of similarities among profiles of student survey ratings of the hypertext system. The algorithm located a cluster partition of hypertext presentation components including graphics, color, text, and examples. Students rated these components high across all evaluative criteria. Figure 6 profiles student rating for the system's graphic component by evaluative criteria. The system's color, text, and examples components had similar profiles.

Another cluster partition identified components related to information retrieval including navigation, indexes, general usability, and backtracking. Student ratings included more medium and low evaluations for these components. Figure 6 also shows a profile of the navigation component that is representative of components in this partition. The system's printing component stood alone as student ratings reflected general dissatisfaction with the system's ability to print hard copy documentation.

Figure 7 shows a set of ratings of instructional helpfulness among all system attributes. Students highly rated the helpfulness of the system's color, text, backtracking, examples, and general usability.

DISCUSSION AND FUTURE DIRECTIONS

The goal of the hypertext system was to guide students through the analysis, design and implementation stages of a database project. The system's evaluation addressed student impressions of the hypertext components and tested for differences in peer evaluations between groups receiving traditional instruction and those assisted with hypertext.

With the exception of time spent on the project, we were unable to detect significant differences between the student control groups and the groups of students assisted with a hypertext system. Both groups were generally satisfied with the project outcomes and their group members' contributions. The inability to detect significant differences between groups does not warrant the conclusion that hypertext instruction is equivalent to traditional instruction. Additional empirical research studies with more powerful experimental designs, improved outcome measures, and larger samples are needed.

Students reported the hypertext facilities assisted them in learning to construct a database application. Analysis of students' surveys revealed differences in rating profiles between the system's presentation and navigational facilities. Additional research could categorize student experiences and address the causes for the diversity in rankings. A better understanding of student experiences with hypertext systems could lead to improved strategies for customizing hypertext based presentation and navigational strategies (7).

Student experiences with the hypertext system are encouraging and support the claim that the system's components assist students in implementing database applications. The system is evolving and future work includes expanding the system's scope to a semester long business case that will build upon the current design. The extensions will challenge students to develop and refine successive versions of a business information system.

The WinHelp architecture leverages students' past experiences with Windows applications and students found it easy to use. The WinHelp architecture also supports future extensions by providing an open interface for incorporating additional nodes and links.

REFERENCES

1. Engelbart D. C. (1988). "A Conceptual Framework for the Augmentation of Man's Intellect". In Irene Greif (ed.). Computer-Supported Cooperative Work. Morgan Kaufmann: San Mateo CA.

2. Campagnoni, F.R. and K. Ehrlich. (1989). "Information Retrieval Using a Hypertext-Based Help System." *ACM Transactions on Information Systems, 7*(3) 271-291.

3. Conklin J. (1988). "Hypertext: An Introduction and Survey." In Irene Greif (ed.). *Computer-Supported Cooperative Work.* Morgan Kaufmann, San Mateo CA.

4. Haan B, P. Kahn, V. Coombs and N. Meyrowitz. (1992). " Iris Hypermedia Services." *Communications of the ACM. 35*(1) 36-51.

5. Khalifa M. (1993). "Non Linear Instruction of MIS: Why and When." *Journal of Information Systems Education. 5*(2) 28-34.

6. Landow, G.P. (1990). "Popular Fallacies about Hypertext. In D.H. Jonassen and H. Mandl (Eds.) *Designing Hypermedia for Learning.* Springer Verlag: New York, N.Y. 45-67.

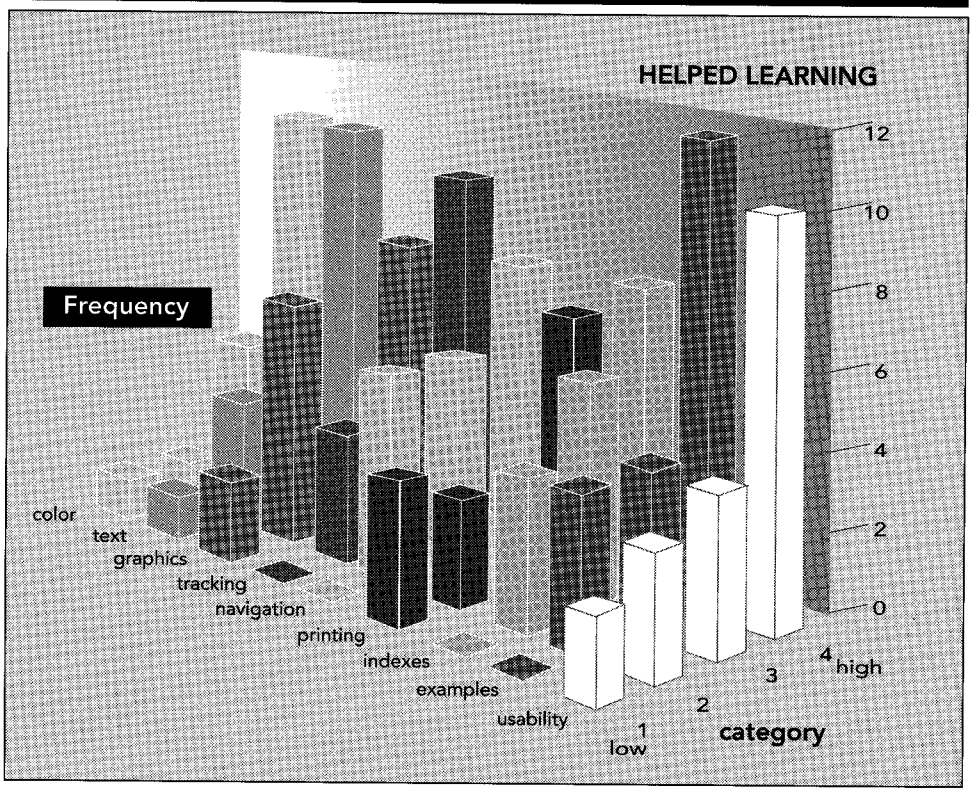
7. Instone K. B. Teasley and L. Leventhal. "Empirically-based Re-design of a Hypertext Encyclopedia."Proceedings of *INTERCHI.* (Amsterdam, The Netherlands, 24 April-29 April,1993). ACM, New York, NY. 500-506.

8. Whalley P. (1993). "An Alternative Rhetoric for Hypertext" In C. McKnight, A. Dillon and J. Richardson (Eds.) *Hypertext A Psychological Perspective.* Ellis Horwood: New York, NY. 7-17.

9. Hammond N. (1993). "Learning with Hypertext: Problems, Principles and Prospects." In C. McKnight, A. Dillon and J. Richardson (Eds.) *Hypertext A Psychological Perspective.* Ellis Horwood: New York, NY. 51-69.

10. Garzotto F, P. Paolini and D. Schwabe (1992) "HDM- A Model-Based Approach to Hypertext Application Design." *ACM Transactions on Information Systems, 11*(1) 1-26.

Figure 7. HISTOGRAM OF STUDENT RATING OF THE SYSTEM'S ATTRIBUTES BY INSTRUCTIONAL HELPFULNESS



11 MacKnight and S. Balagopalan (1989). "An Evaluation Tool for Measuring Authoring System Performance." *Communications of the ACM. 32*(10) 1231-1236.

12. Microsoft Corporation (1992). *Mircosoft Windows 3.1 Programmer's Reference: Volume 4 Resources.* Microsoft Press: Redmond, Washington.

13. Hanson S. J. and M. Bauer. (1986). Machine Learning, Clustering and Polymorphy. In L.N. Kanal and J.F. Lemmer (Eds.) *Uncertainty in Artificial Intelligence.* North-Holland: New York, NY.

14. Norman D.A. (1983). "Some Observations on Mental Models." In D. Gentner and A.L. Stevens (Eds.), *Mental Models.* Elservier: Hilsdale, NJ.

15. Stair, Ralph (1992). *Principles of Information Systems: A Managerial Approach.* Boyd and Fraser: Boston, MA.

16. Presby P. (1992). *Using DBaseIV.* Houghton Mifflin: Dallas, Texas.

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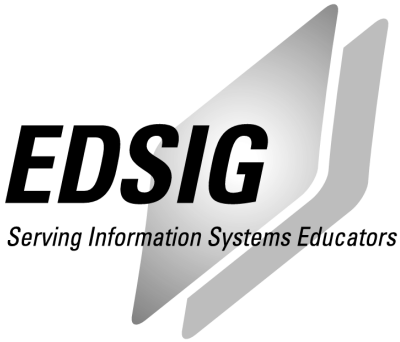

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