AMCIS 1999 Proceedings

Americas Conference on Information Systems (AMCIS)

December 1999

Prepare to be shocked: Hypermedia does not improve learning!

Andrew Dillon
Indiana University

Ralph Gabbard
Indiana University

Follow this and additional works at: http://aisel.aisnet.org/amcis1999

Prepare to be shocked: Hypermedia does not improve learning!

Andrew Dillon & Ralph Gabbard
HCI Lab, SLIS
Indiana University
Bloomington IN 47405
(adillon@indiana.edu)

Abstract

We reviewed the findings of 35 experimental studies of hypermedia use in educational tasks which emphasized quantitative, empirical methods to assess learning outcomes. The review found three broad themes in the literature: studies of learner comprehension compared across hypermedia and between other media; effects on learning outcome of the increased learner control offered users in hypermedia environments, and the individual differences that exist in learner response to hypermedia. The findings indicate that the benefits of hypermedia in education are limited to learning tasks reliant on repeated manipulation and searching of information. There exist significant individual differences in the response of learners to this technology. The majority of findings do not provide eviudence for increased learning in hypermedia environments, a conclusion that runs contrary to the popular advocacy of this technology for training and education.

Introduction

Over the last two decades the emergence of digital documents has evolved from simple word processed text, through standalone hypermedia applications, to the World Wide Web of distributed digital documents. Despite the technological progress, the lessons from user studies of such tools indicates many problems routinely overlooked in discussions of education and training. As a result, hypermedia learning environments are advocated by many authors as a paradigmatic advance in educational technology for one or more of the following reasons:

(1) hypermedia enables non-linear access to vast amounts of information (Nielsen 1995)

(2) users can explore information in-depth on demand (Collier, 1987)

(3) interaction with the instructional material can be self-paced (Barratt, 1988)

(4) hypermedia is attention-capturing or engaging to use (Jonassen, 1989)

(5) hypermedia represents a natural form of representation with respect to the workings of the human mind (Delany and Gilbert, 1991)

The tone of much of this writing is celebratory rather than critical and rarely presents any supporting evidence from studies of learners. Landauer (1995) reported that despite numerous published reports on the topic of hypermedia use, he could only find nine studies of human performance with this technology that met even minimally acceptable scientific criteria. Chen and Rada (1996) identified 23 experimental studies involving human interaction with various forms of hypertext in their review of the literature up to 1993. They adopted less strict criteria for acceptance than Landauer, and counted papers with more than one study repeatedly on the basis of number of experiments reported (they identified a total of 18 papers, including unpublished theses), but even their analysis of effect size showed little real advantage for hypertext over other media in general information tasks, not just learning. We set out to improve on both reviews by explicitly targeting experimental findings published in the 1990s where learning outcome was a primary research question.

Focus of the review

We sought published studies of hypermedia use and learning outcome that were empirical (based on user data), experimental (here considered as meeting rudimentary scientific requirements for selection, manipulation and control of variables), and primarily quantitative. Our emphasis was on the *measured* effects of hypermedia usage on learning outcomes, which we defined here as any desirable and demonstrable changes in learner behavior or learning task performance as a function of instruction or information presentation For this review we considered hypermedia to be a generic term covering hypertext, multimedia, and related applications involving the chunking of information into nodes that could be selected dynamically.

Research Methods

The review concentrated on research findings published between 1990 to 1996 abstracted in the following periodical indexes; (1) Educational Resources Information Center (ERIC) database, and (2) PsychLIT database. The final list provided a total of 30 papers that finally met all criteria in this study. Supplementary papers cited by authors reviewed and/or known to the present authors through their own research works were included where they offered unique perspectives to this main body of work (another 5 papers). This represents a substantial increase in the number on which Landauer (1995) based

his conclusions (precise overlap is impossible to assess since Landauer did not list all nine studies). The final set employed included only 3 of the 18 articles reviewed by Chen and Rada.

The general review can be broken into three major themes, each representing an issue that researchers have focused upon directly:

> (1) comprehension of presented materials;
> (2) learner control over the presentation of
> material;
> (3) individual differences in learning
> style.

Comprehension is a classic outcome measure of performance and perhaps the strongest test of a learning technology. In these studies, researchers compared hypermedia with other media such as paper, or compared various hypermedia versions of information (i.e., they manipulated interface features), and measured the performance of learners with these tools. The second theme is a process issue relating to the control of presentation, pace and movement through the information space etc., variables which are thought to improve the sense of control a learner has over their task and, theoretically, which will therefore affect learning positively (e.g., Landow and Delany 1991). The third issue is an individual difference analysis, with the focus on types of learners for whom certain forms of hypermedia might offer specific learning advantages. We provide very brief snapshot of the findings here. Full details can be found in Dillon and Gabbard (1998).

Summary of comprehension findings

There were twelve articles that measured comprehension and while the results are at best inconclusive, the weight of evidence points to hypermedia advantages mainly for a limited range of tasks involving substantial searching, or manipulation and comparison of visual detail where overlaying of images is important. In such cases the technology affords manipulations and representations of the information that are difficult to support on paper (e.g. animation, accurate searching of large documents etc.) In short, the empirical evidence does not support the use of most hypermedia applications where the goal is to increase learner comprehension (however measured). Evidence from studies of hypermedia structural variables suggest that knowledge of how best to organize information in digital form that exploits the cognitive capabilities of learners to link and organize new information is very limited, yet it is this feature of hypermedia that distinguishes the technology from other media.

Summary on Learner Control findings

With its embodiment of structure and linked information nodes, hypermedia applications are considered by many to offer users far more control over an information space, with the ability to follow links in a self-directed manner being the most cited advantage. From an experimental perspective, user control can be manipulated in myriad ways, and the degree of control any one application embodies is often difficult to measure. In our review it seems that most researchers do not quantify control but rank order degree of control by manipulating the provision of selectable links and paths. Five studies explicitly manipulated the control variable.

Different students seem to react to this increased control differently, with lower ability students manifesting greatest difficulty in exploiting it to their advantage. This is problematic for hypermedia advocates since the technology is often seen as a means of enhancing the performance of weaker students. As a general characteristic of hypermedia environments, the ability to control pace and delivery of information, even when coupled with selection advice, appears insufficient to effect learning outcome significantly for all but high ability learners.

Summary on Learner Style

Individual differences were specifically studied in 10 papers we reviewed. As suggested by the control findings, individual differences between learners seem to matter. Several studies report that high ability learners perform better than low ability learners, regardless of the medium of instruction. Hypermedia applications can offer techniques such as explicit cueing that can aid the weaker student to perform better. Obviously, this area needs much more research to yield the form of evidence that can drive design or exploitation of the technology but it does suggest that a detailed examination of the use of hypermedia in education should be based on appropriately designed technology aimed at specific learners if any significant benefits are to be obtained.

General Conclusion

The benefits gained from use of hypermedia technology in learning scenarios appear to be very limited and not in keeping with the generally euphoric reaction to this technology in the professional arena. To the present authors, the experimental evidence to date suggests three broad conclusions:

(1) Hypermedia affords most advantage for users in specific tasks which require rapid searching through lengthy or multiple information resources and where data manipulation and comparison is necessary.

(2) Increased learner control over access is differentially useful to learners according to their abilities. Lower ability students have greatest difficulty with hypermedia.

(3) Passive learners may be more influenced by cueing of relevant information, and the combination of learner ability and willingness to explore may determine how well learners can exploit this technology.

From these broad conclusions it can be inferred that the value of hypermedia in pedagogy is limited. As hypermedia is ultimately a form of information presentation, there should be no real surprise here. That manipulating form of delivery produces mixed results is a reflection of the gaps in our knowledge of how best to design media and since most educators are fully aware of the multiple forces that shape learning outcome, we should not pin undue hope on any technology of presentation yielding major breakthroughs on education outcome.

However, in tasks that involve multiple, rapid manipulations of complex material, in multiple forms, where term searching is important, or the ability to overlay images or run simulations are involved, then the technology is likely to offer many benefits, all else being equal, if the specific form is designed to be usable. Obviously, combining the technology with innovative classroom use, discretionary collaboration, and self-paced learning may offer further advantage, but as yet these scenarios remain largely unstudied.

Taking the literature as a whole, it is disappointing to report that statistical analyses and research methods are frequently flawed, limiting our understanding of these important issues. Failure to control important variables for comparative purposes, lack of adequate pre-testing of learners, the use of multiple t-tests for post-hoc data and even the tendency to claim support for hypotheses when the data fail to show statistically significant results, all suggest that the basis for drawing conclusions from this literature is far from sturdy.

Recommendations

While the results are an eye-opener for many people interested in exploiting hypermedia information systems for training and education, we feel that there are pointers for improvement.

There are clear indications that the successful exploitation of the technology requires its design and use be grounded in a thorough understanding of the learning task. For tasks involving lengthy reading and consideration of materials, hypermedia seems to offer little that cannot be provided by traditional media. Furthermore, in such task scenarios, traditional media offer their own advantages in terms of image quality, familiarity of form and portability For tasks that require users to sift through large amounts of information to locate details, where complex details might be compared through overlay or animation, and where multiple resources might need to be searched and collated, the digital medium offers functionality that is superior to other media.

As Dillon (1994) noted, any learning task can be decomposed into a variety of elements: reading, manipulating, formulating and monitoring task goals, constructing a mental model of the information etc. The medium of presentation affects each of these somewhat differently depending on their duration and frequency within the task structure. The mistake is to assume that all elements are equally important for all tasks. Part of the design problem for hypermedia instructional contexts is the proper exploitation of the appropriate functions at the appropriate time.

As well as a grounding in tasks, an understanding of the user population is vital. Since we observe significant individual differences between learners using this technology there is a need to address this issue. Hypermedia not only hinders certain users, but it might be an enhancer for others. Beyond cognitive style of information processing differences there also exist a range of other potential sources of user variance: expertise, task experience, technology disposition etc., all of which are known to MIS professionals as important determinants of system use. Hypermedia is no different in this regard and there is need for better understanding of how these differences impact instruction and training with any technology.

The problems are clear, but the means of improving our designs are also within our grasp. Appropriate user and task analyses, combined with iterative design and testing in a user-centered manner could lead to far better exploitation of hypermedia technology.

Bibliography

Available form the authors.