Hypermedia and Learning: the State of the Art

Extended Bibliography (in progress)

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by Maggie Swan, Andrew Dillon and Michelle Fuhrman

SUMMARY

This document provides a bibliographical list of references for the topic of hypermedia and learning as being studied and tested for the IU Digital Music Library project. It is expected that as sources become timely and available they will be added to this list, thus, this document should be considered "in-progress" and (as it currently stands) by no means exhaustive with regard to the literature on hypermedia and learning.

In addition to citation information, both the focus of the article and study results are documented according to the following variables:

- **User Characteristics –** Individual cognitive differences such as learning, navigational, and information processing styles, among others, may contribute to the ways in which learners interact with a hypermedia system. Currently, the importance of several user variables has been noted in the literature. Empirical study of the connections between user characteristics and their subsequent effects on performance may lead to more efficient, effective and satisfying design of hypermedia instructional systems for all categories of users.

- **Task –** The type of task a user may execute on a hypermedia system is mediated by both the elicited purpose of the system and its design affordances. In the case of hypermedia learning systems, the task is generally to complete a lesson with the goal of increased topic understanding through exploration or concept formation. Performance may be measured in terms of task completion rates, task times, assessment scores, etc. Studies have shown the task dependency of hypermedia's impact on learning.

- **Tool –** Increasingly, hypermedia tools are being used in the classroom to replace traditional learning scenarios or provide learning enhancement. Hypermedia systems may take various forms, including teacher-produced systems using commercial authoring tools, and lessons navigated on the World Wide Web. Hypermedia tools may be used with various audiences (i.e. 5th graders vs. adult learners) and so these tools must be gauged for appropriate level of difficulty with regard to reading level, knowledge structure, and aesthetic appeal, etc. Hypermedia learning tools are often assumed to contribute to increased performance, but empirical evidence has shown contrary/mixed findings in this area.

- **Context –** The settings in which hypermedia tools are employed range from traditional classrooms and computer labs to distance learning and information searching situations (e.g. public library). The particular context in which learners use a hypermedia tool may influence how well the tools fits user needs.

- **Miscellaneous –** This category is reserved for articles pertaining to use of hypermedia in educational settings that do not easily fit in any of the above sections. Examples of content in this category include papers that proffer overarching theories, literature reviews, and discussions of the implications of using HCI guidelines in educational environments.

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USER

Author (citation)	User Characteristic(s)	Results
Barab, S., Bowdish, B., & Lawless, K. (1997). Hypermedia Navigation: Profiles of Hypermedia Users. *Educational Technology Research and Development, 45(3),* 23 – 41.	• Navigation style	*N=71* • There exist certain profiles of users who are susceptible to unwise navigational decisions, and who are prone to being distracted by unimportant details and superfluous features (such as videos and other unnecessary multimedia).
Chen, S. & Ford, N. (1998). Modeling User Navigation Behaviors in a Hypermedia-Based Learning System: An Individual Differences Approach. *Knowledge Organization, 25(3),* 67-78.	• Navigation style	*N=20* • Students with differing cognitive styles and individual characteristics select different access facilities and apply different navigation patterns.
Chen, S. & Ford, N. (2000). Individual differences, hypermedia navigation, and learning: An empirical study. *Journal of Educational Multimedia and Hypermedia, 9(4),* 281-311.	• Individual differences: cognitive style (field-dependence/independence), prior experience, motivation, age, & gender • Learning behavior: navigation patterns, levels of depth • Assessment: criterion-based scores, time spent, sequence	*N=65* • Concluded that learning strategy evidence is less consistent in relatively nonlinear learning environments and that learning outcomes are not significantly affected by observable learning strategy differences. • No significant interactions b/t learning strategies displayed by learners of different cognitive style and performance. • Field-independent students had significantly greater levels of prior experience of using computers and HTML. • Females were motivated to attend tutorial sessions for relatively extrinsic reasons compared to males. • Field I-D was significantly linked to learning behavior aspects. Field-dep learners made greater use of Map, less use of Index and back/Forward buttons, scored higher as holists, adopted "random order" approach to the elements of practical assessment task, among others. Converse was true for field-I learners. • No significant outcomes between field-i/d and measures of learning outcomes. • Significant correlations between experience of Internet use and web page creation and gain in pre-post test scores. • Significant correlations b/t experience of computer use and doing practical task in ascending order of task complexity, as opposed to initial task order

		presentation. • Students with higher levels of prior experience viewed a greater # of pages, a greater total # of levels in the subject hierarchy, spent less time learning, and spent less time attempting the practical assessment task. • Compared to younger students, older students made greater use of the Index and spent a relatively low proportion of their time visiting level 1 in the subject hierarchy.
Dillon, A. & Gabbard, R. (1998). Hypermedia as an educational technology: A review of the quantitative research literature on learner comprehension, control, and style. *Review of Educational Research, 68(3),* 322-349.	• Learner comprehension • Control • Style	• Major review of published quantitative studies of learner performance in hypermedia environments. Consludes there are significant individual differences among users, and that many studies in this domain are poorly designed and show few significant results.
Gyselinck, V., Ehrlich, M. -F., Cornoldi, C., de Beni, R., & Dubois, V. (2000). Visuospatial working memory in learning from multimedia systems. *Journal of Computer Assisted Learning, 16,* 166-176.	• Comprehension and effects of pictorial aid	*N=48* • Comprehension performance was aided by the illustrations; however, it was not affected by the concurrent tasks. • The beneficial effect of illustrations was more important for inferential questions than for factual questions, which suggests a deeper understanding.
Lawless, K. & Kulikowich, J. (1996). Understanding Hypertext Navigation Through Cluster Analysis. *Journal of Educational Computing Research, 14(4),* 385-399.	• Navigational profiles	*N=42* • Individuals reading a hypertext may navigate differently depending on the nature of the domain. (well-structured –math, physics - vs. ill-structured history, literature) • Developmental differences may also influence navigation style. (grad vs. undergrad)
Lee, M. J. & Harvey, F. (1999). The relationships between navigational patterns and informational processing styles of hypermedia users. *Proceedings of Selected Research and Development Papers Presented at the National Convention of the Association for Educational Communications and Technology. Research and Theory Division, Houston, Texas. Editors: Sparks, K. and Simonson, M.*	• Information processing styles • Navigational patterns	*N=102* • Right dominant information processors accessed significantly more new nodes than left dominant. • There was a significant relationship between information processing style and navigation path pattern: right dominant information processors followed significantly more linear paths than the integrated information processing style subjects. • There was a significant relationship between information processing styles and navigational method patterns: left dominant information processors employed significantly more analytical methods than the right dominant information processing style subjects. The integrated information processing style

		subjects used significantly more analytical methods than the right dominant information processors.
Liu, M. & Reed, M. (1995). The effect of hypermedia assisted instruction on second language learning. *Journal of Educational Computing Research, 12(2),* 159-175.	• Learning a foreign language • Effect of learning styles on vocabulary learning in this environment	*N=63* • Learning style had no significant impact on achievement. Researchers suggest this implies that learners' needs were accommodated by the hypermedia.
MacGregor, S. (1999). Hypermedia Navigation Profiles: Cognitive Characteristics and Information Processing Strategies. *Journal of Educational Computing Research 20(2),* 189-206.	• Navigation profile/style	*N=10* • Analysis of characteristics of students within each profile revealed similar levels of prior knowledge, need for cognition, and self-efficacy. • Prior experience had a positive influence on the complexity of the conceptual maps the students produced.
Melara, G. (1996). Investigating learning styles on different hypertext environments: hierarchical-like and network-like structures. *Journal of Educational Computing Research, 14(4),* 313-328.	• Learning style – Kolb • Navigation structure – hierarchical vs. network	*N=40* • Both structures were equally effective for accommodating learners – no significant difference was found between the two learning styles. • For time spent completing the instruction, a significant difference was found between learners using the hierarchical and learners using the network structure (hierarchical took longer).
Oughton, J. & Reed, W. (2000). The effect of hypermedia knowledge and learning style on student-centered concept maps about hypermedia. *Journal of Research on Computing in Education, 32(3),* 366-384.	• Learning style – Kolb • Levels of hypermedia knowledge	*N=21* • Assimilators and Divergers produced more complete concept maps. Accommodators were somewhat consistently the least-productive group. • High-hypermedia knowledge students had the deepest level of processing.
Paolucci, R. (1998). The Effects of Cognitive Style and Knowledge Structure on Performance Using a Hypermedia Learning System. *Journal of Educational Multimedia and Hypermedia, 7(2/3),* 123-150.	• Cognitive style • Knowledge structure	*N=115* • Significant differences were found among the three knowledge structure schema groups (conventional, branching, and hierarchy) for the total and the higher order cognitive skills performance scores. No significant relationship was observed between cognitive style and performance, nor did this variable significantly interact with the knowledge structure variable. • A relationship was observed between the structuring of the knowledge domain, as reflected by the hypermedia software, and positive learning performance.
Rasmussen, K. L., & Davidson-Shivers, G. V. (1998). Hypermedia and learning styles: can performance be influenced? *Journal of Educational Multimedia and Hypermedia, 7(4),* 291-	• Learning styles (active vs. reflective) • Learner control based on structure: hierarchical, hierarchical with associative,	*N=102* • Individuals who had preferences toward active learning preferred low levels of learner control and performed best in the hierarchy structure. • Reflective learners performed highest in the hierarchy

308.	or web.	with association (moderate) structure.
Reed, M., Ayersman, D. & Liu, M. (1996). The Effects of Students' Computer-Based Prior Experiences and Instructional Exposures on the Application of Hypermedia-Related Mental Models. *Journal of Educational Computing and Research, 14(2),* 185-207.	• User awareness of mental models present in a hypermedia environment	*N=15* • More experience in the areas of programming, authoring, and hypermedia is positively related to the ability to identify mental models, linear or nonlinear.
Weller, H., Repman, J., Lan, W. & Rooze, G. (1995). Improving the effectiveness of learning through hypermedia-based instruction: the importance of learner characteristics. *Computers in Human Behavior, 11(3-4),* 451-465.	• Field-independent vs. field-dependent • Magnet vs. non-magnet (magnet = academically talented)	*N=33* *N=98* • In both studies, field-independent students learned more effectively from HBI (hypermedia based instruction) than field-dependent. Magnet students learned more effectively from HBI than non-magnet, regardless of group composition (all groups were: mag and non working together, mag group, mag indiv., non group, non indiv.) • Disparity in enabling students to learn via HBI seems to be due to mismatches of human-computer interactivity with learner characteristics. • Magnet students who studied via the HBI individually or in pairs had higher achievement on the posttest than all other students. For magnet students, studying with another magnet student apparently did not result in more effective learning than studying alone. For non-magnet student, being paired with another student during HBI resulted in significantly better learning than when studying alone, whether the other student was non-magnet or magnet.

TASK

Author (citation)	Task(s)	Results
Berz, W.L. (1995). Navigational Behaviors in Hypermedia Documents in Music. *The New Review of Hypermedia and Multimedia, 1(1),* 169-183.	• Supplemental music instruction • Recognition of musical instruments by sound	*N=38* • Students spent over one-third of their time accessing information that was outside of the instructional objective of the lesson. • There was little discussion or cooperative activities between dyad members throughout the use of the hypermedia, contrary to expectation.
Dubois, M. & Vial, I. (2000). Multimedia design: the effects of relating multimodal	• Learning foreign language • Different presentation	*N=60* • An integrated image had a better learning result than

information. *Journal of Computer Assisted Learning, 16,* 157-165.	modes, and different retrieval modes. (audiovisual, auditory, visual)	an image alone. Adding an image without an explicit link to the material did not improve performance. • Significant differences were found between the auditory recall scores across presentation modes. • An overall improvement in learning when integrated information was presented in the form of sound was observed. • The more the recall conditions are matched to the encoding modes, the better the learning is.
Hill, J. & Hannafin, M. (1997). Cognitive Strategies and Learning from the World Wide Web. *ETR&D, 45(4),* 37-64.	• Open-ended searching	*N=15* • Learners use a variety of strategies. Self reported knowledge appears to affect the strategies used. • Perceptions of disorientation and perceived self-efficacy influences the strategies used. • Extensive learner control may inhibit success in some electronic learning environments, since learners often do not select wisely when given open-ended choices. • Learners who developed good system knowledge successfully completed their searches, while those with low system knowledge were unable to develop system knowledge, expressed disorientation, and were unsuccessful. • Teaching strategies for finding information in open information systems like the WWW may assist learners in their tasks.

TOOL

Author (citation)	Tool(s)	Results
Beasley, R. & Waugh, M. (1995). Cognitive Mapping Architectures and Hypermedia Disorientation: An Empirical Study. *Journal of Educational Multimedia and Hypermedia, 4(2/3),* 239-255.	• Spider maps vs. Hierarchical maps	*N=61* • Results suggest that the inclusion of a properly constructed cognitive map can diminish feelings of disorientation in the learner. • Learners in the hierarchical maps treatment reported feeling significantly less disoriented than learners in the hotwords treatment. • No significant differences in perceived disorientation were found between learners in the hotwords treatment and learners in the spider maps treatment.
Chiu, C. H. & Wang, F. M. (2000). The influence of navigation map scope on disorientation of elementary students in	• Navigational map scope and disorientation	*N=146* • No significant difference between groups for disorientation or number of browsed pages.

learning a web-based hypermedia course. *Journal of Educational Computing Research, 22(2),* 135-144.		• Global maps can be reduced in size and still provide enough information to effectively aid searching.
Jacobson, M., Maouri, C., Mishra, P. & Kolar, C. (1996). Learning with Hypertext Learning Environments: Theory, Design, and Research. *Journal of Educational Multimedia and Hypermedia, 5(3/4),* 239-281.	• Structured hypertext styles: Guided thematic criss-crossing (TCC) and Learner selected TCC	*N=69* • Guided TCC students who regarded learning as an active process of constructing meaning were found to perform at a significantly higher level on a knowledge synthesis task of near transfer than students in the other treatment groups or students with a simpler set of epistemic beliefs.
McDonald, S. and Stevenson, R. (1999). Spatial Versus Conceptual Maps as Learning Tools in Hypertext. *Journal of Educational Multimedia and Hypermedia, 8(1),* 43-64.	• Spatial vs. Conceptual maps as learning tools in hypertext • Exp.1: effects of localized spatial maps, textual contents lists and no aid on subject's ability to answer questions about the subject matter of the text. • Exp.2: compared a spatial map, conceptual map and no aid on navigation and learning.	*N=36* • Exp. 1: A spatial map was significantly better than a contents list at facilitating navigation but the two aids did not differ in their ability to facilitate learning. The no aid condition performed worst on both navigation and learning. *N=32* • Exp. 2: navigation was significantly best with a spatial map whereas learning was best with a conceptual map. No aid navigated poorly, but learning was better than that of the spatial map subjects.
Scherly, D., Roux, L., & Dillenbourg, P. (2000). Evaluation of hypertext in an activity learning environment. *Journal of Computer Assisted Learning, 16,* 125-136.	• Simulated environment vs. just hypertext	*N=29* • Reading time was lower for simulated environment, however, they did just as well on the post-questions, and did better on the post-questions that favored complex knowledge (over declarative knowledge) than the hypertext users did. • Simulated environment group opted not to use the hypertext available to them until after problem resolution, surprisingly to the investigators.
Szabo, M. & Kanuka, H. (1999). Effects of violating screen design principles of balance, unity, and focus on recall learning, study time, and completion rates. *Journal of Educational Multimedia and Hypermedia, 8(1),* 23-42.	• Achievement, completion rate, and lesson time as a function of screens with poor design principles vs. good design principles (unity, focal point, and balance).	*N=52* • There was no difference in achievement scores between subjects who used the lesson with good design principles and those who used the poor design. • Screen design elements of unity, focal point, and balance did not affect recall learning, but subjects who used the good design completed the lesson in less time and had a higher completion rate. • Possible attributions for results are automaticity of control processes while learning, and complexity of cognitive processing as a function of complexity of visuals.

CONTEXT

Author (citation)	Context	Results
Beasley, R. & Waugh, M. (2000). The effects of content-structure focusing on learner structural knowledge acquisition, retention, and disorientation in a hypermedia environment. *Journal of Research on Computing in Education, 28(3),* 271-282.	• Effects of content-structure awareness on knowledge acquisition, retention, and disorientation.	*N=61* • When a learner's attention is at least partially focused on the structural aspects of a hypermedia lesson—due to an awareness of a required, post treatment activity—structural knowledge acquisition will increase. • When a learner's attention is at least partially focused on the structural aspects of a hypermedia lesson, disorientation in the learner will decrease.
Beaufils, A. (2000). Tools and strategies for searching in hypermedia environments. *Journal of Computer Assisted Learning, 16,* 114-124.	• Research, integrated "trail-marking" and tailoring of information while doing research, as well as note taking (only, the system was a prototype, and the note taking was on paper)	*N=5* • When given preliminary advice concerning methodology (invited to study the question in more depth), students were capable of producing a greater number of search criteria and the exploration of the database was more methodological. • The modifications made to the database by the students were not always satisfying. Modification of user interface led to better acquaintance with the environment and better use of the tools. • The activity of note-taking performed by students at every stage of their info search favored how they managed the search and in particular its planning. • However, installation of a note-taking system poses real ergonomic problems and risk of cognitive overload and confusion.

MISCELLANEOUS

Author (citation)	Content	Results
Berg, G. A. (2000). Human-computer interaction (HCI) in educational environments: implications of understanding computers as media. *Journal of Educational Multimedia and Hypermedia, 9(4),* 349-370.	•	•