

# Hypermediated Learning: Learning Styles, Path Analysis, and Knowledge Outcomes

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**Abstract:** This paper discusses the results of a study to determine the effects of prior computer use, student rank, and differences in levels of field dependence/independence on learning outcomes within a hypermedia program for preservice teachers in special education. No differences were found for achievement, construction of concept maps, on-line test scores, or problem-solving scores which were related to prior computer knowledge, student status, or learning styles. Participants with differing learning styles used the program an equivalent amount of time and accessed information similarly. Differences were found in the proportion of time they spent across two of the four hypermedia instructional components but these differences did not influence learning outcomes.

## 1 Introduction

In spite of current enthusiasm for hypermedia-based instruction, most researchers agree that insufficient evidence exists to determine whether outcomes match the proclaimed promises of hypermedia. Because hypermedia can provide a flexible, efficient, nonlinear, and associative learning environment, educators have embraced its format without sufficient research on its effects (Liu, 1994). As stated by Harmon and Dinsmore (1994), "most developers assume that, because hypermedia *ought* to be good for instruction, it *is* good for instruction" (p. 157). The excitement for the approach largely rides on the notion that learners *can* and *will* customize their instructional choices in a hypermedia program to fit their preferences and learning styles. Limitations to hypermedia have also been cited (Jonassen, 1989), and it may be that hypermedia is not suitable for all learners.

Research is in its infancy in studying relationships of learner characteristics, hypermedia formats, patterns of use, and learning outcomes. To date, existing research is sparse on a number of these factors and what exists is difficult to synthesize due to differences in lengths of treatment, subjects, features of the hypermedia programs, and outcome measures. This study focused on learning outcomes for adult learners utilizing a robust hypermedia program in a lengthy treatment.

## 2 Research Questions

The study was designed to address the following research questions about hypermediated learning:

- (a) Is there a relationship between prior experience using computers with learning outcomes of students using a hypermedia-based instructional program?
- (b) What effects does a hypermedia-based instructional program have on learning outcomes for preservice teachers representing two class ranks and different levels of field independence/dependence?
- (c) Do preservice teachers with different levels of field independence/dependence utilize a hypermedia learning environment differently with regard to engagement time and patterns of accessing information?
- (d) Do preservice teachers with different levels of field independence/dependence perform differently in a hypermedia learning environment with regard to mastery of content and on-line problem-solving activities?

### **3 Treatment: The Hypermedia Instructional Program**

#### **3.1 Instructional Content and Purpose**

The hypermedia program used in this study was *Perspectives on Emotional and Behavioral Disorders* (Fitzgerald, Semrau, Kraus, Nichols, & Glickert, 1995). The materials utilize a case study format featuring three youngsters with behavioral problems in school settings. Each case study includes an opening challenge scenario and case information presented via software, audio and video support materials residing on a videodisc. Users explore information from a variety of theoretical perspectives by: (1) observing children in a variety of situations; (2) "interviewing" their teachers and parents; (3) seeking background knowledge and case information; (4) comparing and contrasting multiple theoretical views; (5) hearing "experts" discuss the cases; and (6) engaging in problem solving and planning activities within the case studies.

#### **3.2 Underlying Instructional Design**

Through the interactive case study approach, the learner is expected to develop a cognitively flexible understanding of the complex, multiple theories and approaches used in formulating intervention programs for students with emotional and behavioral disorders. "Cognitive flexibility" involves the *selective* use of knowledge to *adaptively fit* the needs of understanding and decision making in a particular situation. "Ill-structuredness" means that many concepts (interacting contextually) are pertinent to a specific case, but that their patterns of combination are inconsistent across case applications of the same nominal type (Spiro, Feltovich, Jacobson & Coulson, 1991). The instructional approach utilized in this program strives to develop cognitive flexibility to enable the learner to construct knowledge based on complex and irregular situations. It focuses on the construction of knowledge structures and the application of that knowledge structure to problem solving.

Cognitive flexibility can be enhanced through effective design of hypermedia programs by situating problem solving in authentic case scenarios, providing factual and procedural knowledge within the discipline, scaffolding the learner through guided activities and embedded structure, and modeling the reasoning processes of experts. To evaluate the success of the hypermedia design to develop knowledge and cognitive flexibility, variables related to knowledge acquisition, concept development, cognitive re-structuring, and problem solving must be examined.

#### **3.3 Software Audit Trail**

The computer program contains a complete data collection system to capture usage data and learning outcomes through an audit trail (Misanchuk & Schwier, 1992). The datapath for the user provides a continuous record of the user's sequence through the various components and activities and time spent in each component. The written records entered into the computer problem-solving activities are stored in separate files on floppy disks.

### **4 Participants in the Study**

Subjects were twenty-three preservice teachers enrolled in a methods course in behavioral disorders. All students had completed foundational coursework in special education and had substantial prior knowledge upon which they began to develop specialized knowledge in the area of behavioral disorders. Demographic information for the participants served as independent variables.

#### **Prior Computer Experience**

Almost all participants had experience using computers for general productivity tool uses, particularly word processing. Most students had never experienced hypermedia programs and only two students responded that they had "some knowledge" of hypermedia. Based on a scale where students rated their experience from 0 = "no knowledge" to 9 = "expert knowledge" on 9 categories of computer applications (total score possible = 81), the mean prior experience score = 25, standard deviation = 10.78, range = 5 to 43.

## Rank in School

The participants included 17 seniors and 6 post-baccalaureate/graduate students.

## Learning Styles

Participants represented a mix of field independence and field dependence as measured by their scores on the Group Embedded Figures Test (Witkin, Oltman, Rashkin, & Karp, 1971). Using quartile scores to segment the participants into learning style groups, 4 participants were classified as field dependents (FD), 11 as field dependents mixed (FDM), 5 as field independents mixed (FIM), and 3 as field independents (FI).

## 5 Data Collection for Dependent Variables

Data were collected prior to use of the hypermedia program (pre) and following completion of the last case study (post). A *knowledge test* consisting of 25 multiple choice questions was constructed from test banks available for two of the primary textbooks used in the field. The content of the information base contained within the hypermedia program was consistent with the content of the textbooks and the knowledge test.

Each student constructed a *concept map* prior to use of the hypermedia program (pre) and following completion of the last case study (post). The maps displayed how each student would organize his or her approach to understanding a child with a behavioral disorder. The concept maps were constructed during supervised class time within a 30-minute time frame without the use of notes or advanced notice of the activity. Each concept map was scored for (a) number of unique concept nodes, (b) number of links between nodes, and (c) number of levels constructed in the concept maps.

*Path analysis data* were collected from records stored on user floppy disks. Data collected from the audit trail included (a) total time spent on each of the case studies, (b) total time spent in each of the program choices, (c) the number of times each program choice was accessed, (d) results of an on-line quiz embedded within each case study, and (e) electronic responses to all on-line problem-solving activities included within the case studies.

## 6 Data Analysis and Results

### 6.1 Outcomes Related to Prior Experience with Computers

Simple regressions were run to evaluate whether outcomes of hypermedia-based instruction were related to differing levels of prior experience with computers. Table 1 presents the regression results for four dependent outcome variables: a) knowledge test, b) number of unique concept nodes on concept maps, c) number of links on concept maps, and d) number of levels included in concept maps. Regressions were run for pre as well as post outcome scores. No significant relationships were found to indicate that prior computer experience was related to differences in pre-treatment scores. Similarly, no significant relationships were found to indicate that prior computer experience predicted learning outcomes based on hypermediated instruction.

	Pre Treatment			Post Treatment		
	<i>r</i>	<i>F</i> -value	<i>p</i>	<i>r</i>	<i>F</i> -value	<i>p</i>
Knowledge score	.129	.357	.557	.164	.357	.557
Number of unique concept nodes	.060	.976	.786	.060	1.544	.228
Number of links	.156	.523	.477	.020	.523	.477
Number of levels	.146	.460	.505	.029	.018	.896

**Table 1.** Outcomes for Students Blocked by Prior Experience with Computers

## 6.2 Outcomes Related to Student Rank in School

To evaluate whether hypermedia-based instruction affected the learning outcomes of preservice teachers with different levels of higher education, four dependent measures were examined for users blocked into two groups: undergraduate students and graduate/post-baccalaureate students. Table 1 presents the results for two-factor ANOVAs for the dependent variables: a) knowledge test, b) number of unique nodes on concept maps, c) number of links on concept maps, and d) number of levels on the concept maps. Results are included for the group (rank) and outcome (pre/post) main effects. Findings revealed no significant differences in learning outcomes using the hypermedia program which were related to student rank in school.

	Undergraduate		Graduate		Rank		Pre/Post	
	Post	Mean	Post	Mean	F-value	p	I-value	p
Knowledge score		18.88		18.17	.639	.434	106.147	.001 *
Number of unique nodes		48.24		52.50	1.291	.269	9.870	.005 *
Number of links		54.77		66.17	3.610	.070	9.470	.006 *
Number of levels		4.77		4.67	.820	.375	.266	.611

**Table 2.** Learning Outcomes for Students Blocked by Rank in School

## 6.3 Outcomes Related to Learning Styles

To evaluate whether hypermedia-based instruction affected the learning outcomes of preservice teachers with different levels of field independence/dependence, four dependent measures were examined for users blocked into four groups: first quartile (field independents - FI), second quartile (field independents mixed- FIM), third quartile (field dependents mixed - FDM), and fourth quartile (field dependents - FD). Two-factor ANOVAs with one within (pre and post) and one between (field independence/dependence) factor were used to analyze differences. Table 3 presents the results of the two-factor ANOVAs for the dependent variables: a) knowledge test, b) number of unique nodes on the concept maps, c) number of links on the concept maps, and d) number of levels on the concept maps. Results are included for the group (learning style) and outcome (pre/post) main effects.

Findings revealed no significant differences on learning outcomes using the hypermedia program that were related to differences in learning style depicted through field independence and field dependence. There were no significant main effects for the group variable. Significant pre-to-post differences were found for knowledge score ( $p = .0001$ ), number of unique nodes on concept maps ( $p = .003$ ), and number of links on concepts maps ( $p = .004$ ). No significant difference was found for the fourth dependent variable, the number of levels contained in the concept maps ( $p = .636$ ).

Post-Scores	FD	FDM	FIM	FI	Learning Style		Pre/Post	
	Mean	Mean	Mean	Mean	F-Value	p	F-Value	p
Knowledge score	18.75	18.91	18.40	18.33	1.272	.312	152.850	<.001 *
Number of unique nodes	42.50	48.55	57.80	47.33	1.429	.265	11.521	.003 *
Number of links	50.50	59.00	64.20	52.00	1.000	.414	11.103	.004 *
Number of levels	6.50	4.36	4.80	3.67	2.364	.103	.232	.636

**Table 3.** Learning Outcomes for Students Blocked by Field Independence/Dependence

## 7 Audit Trail Analysis of Field Dependent and Field Independent Learners

The audit trail records of six students were examined for differences in usage patterns of the hypermedia program. Three students whose scores fell in the first quartile on available norms for the Group Embedded Figures Test were classified as field dependents (FD); three students whose scores fell in the fourth quartile were classified as field independents (FI) (Witkin et al, 1971).

## 7.1 Total Engagement Time

FI users spent 7.27 hours engaged in the two case studies compared to 7.19 hours for FD users. This difference was not statistically significant based on an unpaired t-test analysis ( $t = -.46, p = .96$ ). These results indicate that users with different levels of field independence/dependence engaged in the hypermedia program an equivalent amount of time for learning.

## 7.2 Internal Jumps to Access Information

An analysis was done comparing the number of program choices selected in the final case study by gathering frequency data on button clicking. FI users made more selections with an average of 128 program selections compared to FD users who made an average of 91 selections. This difference was not statistically significant based on an unpaired t-test analysis ( $t = -.88, p = .429$ ). These results indicate that users with different levels of field independence/dependence utilized options in the program with similar frequencies.

## 7.3 Proportional Engagement in Instructional Components

Table 4 displays the proportion of usage time the students engaged in the instructional components of the hypermedia program. Using an unpaired t-test analysis, differences between the FI and the FD users were not significant for seeking information and watching videos; but differences were highly significant for listening to experts and engagement in on-line problem-solving activities. Results indicated that users with different levels of field independence/dependence utilized the hypermedia program in different ways.

Instructional Component	Proportion of Time Mean for FD	Proportion of Time Mean for FI	$t$ (4)	$p$
Seeking Procedural and Case Information	41.59	48.56	-2.015	.114
Watching Videos of Children	8.52	12.95	-1.359	.246
Listening to Expert Commentary	7.19	15.85	-8.038	.001 *
Doing On-line Problem-solving Activities	41.38	22.54	3.651	.021 *

**Table 4.** Proportion of Time Users Engaged in Instructional Components

## 7.4 On-line Quiz Scores

The on-line quiz scores for the case studies were averaged for each user based on the second-attempt score. Second attempts were used instead of first attempts because most users looked at the quiz before making a serious attempt to achieve the criterion score (80%) established by the instructor. FI users achieved an average of 76.7% compared to 73.3% for FD users. This difference was not significant based on an unpaired t-test analysis ( $t = -.447, p = .678$ ). These results indicate that users with different levels of field independence/dependence demonstrated equivalent levels of achievement on the quizzes embedded within the hypermedia program.

## 7.5 On-line Problem-solving Reports

Two scores were derived from on-line reports written as a part of the problem-solving activities in the program. (1) A personal perspectives score rated responses to the on-line question prompts: *What is your perspective of this child's needs?* and *How do you support this position?* (2) A team synthesis score rated responses to the question prompts: *Who would you like to be on the team for this child?* and *What views do your team members share?*

Responses were scored by the two researchers using a holistic scoring rubric and differences were resolved prior to data analysis. On the *personal perspectives* comparison, no significant difference was found between users

with different levels of field independence/dependence. Using a paired t-test analysis, the mean difference was 0.7 on a five-point scale ( $t = -.417$ ;  $p = .698$ ). Similarly, no significant difference was found on the *team synthesis* comparison between users with different levels of field independence/dependence. The mean difference was 0.33 on a five-point scale ( $t = .25$ ;  $p = .815$ ).

Similarity of scores indicated the users were equally successful in solving the case study simulations requiring them to develop personal perspectives toward children with behavioral problems, select therapeutic team members, and synthesize shared goals and beliefs across the team members.

## 8 Discussion

The findings from this study support the belief that hypermedia *is* good for instruction. College-age adult learners who utilized the extensive hypermedia environment demonstrated that they *could* and *would* customize their use of the program. Differences among the learners were documented by three variables—rank in school, prior experiences using computers, and learning style as expressed in field independence/dependence. Given the significant growth in knowledge as demonstrated on the pre/post knowledge test and the increased breadth and complexity of knowledge construction as demonstrated through the concept mapping procedure, it appears that the hypermedia learning environment provided equally effective instruction for learners regardless of their differences.

To examine how field dependent and field independent learners actually utilized the hypermedia program, audit trail records for six users were examined. Although these users spent equivalent amounts of time engaged in the program and demonstrated similar patterns of information access, significant differences were found in their choices within the instructional components of the program. Regardless of these usage differences, performance in on-line quizzes and problem-solving activities was similar.

In summary, users with differing learning profiles and usage patterns were equally successful in knowledge construction. These conclusions may be limited to a robust hypermedia intervention which is effectively integrated into an appropriate instructional program and conducted over a sufficiently long treatment period.

## 9 References

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