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AUTHOR Marchionini, Gary; And Others
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ABSTRACT

Sixteen courses were taught over a 2-year period at eight universities using Perseus, a HyperCard-based hypermedia information system that contains multimedia information about the Greek world, in order to examine how type of assignment influenced student perceptions about the Perseus interface and learning performance. Data collection methods included interviews, observations, automatic transaction logging, questionnaires, and document analysis. Initially, evaluation was mostly formative to provide feedback to the designers; the focus later shifted to summative results that addressed how Perseus affects teaching and learning. Assignments were classified as either directed (high instructor control), undirected (high learner control) or mixed. Those assignments that used both instructional types generally yielded better ratings; directed assignments yielded higher ratings for confidence, and undirected assignments yielded higher ease of use ratings. Additionally, performance ratings were correlated with interface effects, but not with frequency of use or previous computer experience. (Contains 13 references.) (AEF)

Directed and Undirected Tasks in Hypermedia: Is Variety the Spice of Learning?

GARY MARCHIONINI and DELIA NEUMAN
College of Library and Information Services
University of Maryland
College Park, MD, 20742 USA
march@umdd.umd.edu mn9@umail.umd.edu

KENNETH MORRELL
Language Center
Rhodes College
Memphis, TN, 38112 USA
morrell@vax.rhodes.edu

Abstract: Questionnaire data from sixteen courses taught over a two year period at eight universities where Perseus was used was analyzed to examine how type of assignment influenced student perceptions about the Perseus interface and learning performance. Assignments were classified as either directed (high instructor control), undirected (high learner control), or mixed and student responses were compared. Assignments that used both instructional types yielded generally better ratings, although directed assignments yielded higher ratings for confidence that needed information was in the corpus and undirected assignments yielded higher ease of use ratings. Additionally, performance ratings were correlated with interface effects but not with frequency of use or previous computer experience.

One of the thorniest problems in applying hypermedia to learning is related to the problem of user control. For more than thirty years (e.g., Mager, 1964) theorists have argued that learners who exercise control over their own learning are more motivated, can more easily relate new information to their personal knowledge, can adjust pacing to personal abilities, and can benefit from learning that more accurately reflects how people learn outside of school. In summarizing the mixed results from many studies of learner control, Ross & Morrison (1989) noted that learner control is a multi-dimensional construct. For example, high ability learners can manipulate instructional as well as presentational aspects of lessons to their advantage, while lower ability learners benefit from presentational but not instructional control.

Hypermedia technology has captured the imagination of educators for several reasons, including its potential for: expanding learner access to information resources, blurring teaching and learning roles, providing a model for associative and non-linear thinking, and offering learner control. In particular, since hypermedia allow users to decide which link to follow, learner control is provided as an inherent feature of the technology. Based on the assumption that learner control is positive and that hypermedia provides such control, many commentators and designers have proposed strategies to leverage learner control in design (e.g., Kinzie & Berdel, 1990;). There is a tension, however, between learning that is fully under the control of the learner (discovery learning) and learning that proceeds according to carefully sequenced and managed activities (training). Duffy and Knuth (1989) pointed out that simply exploring a domain or engaging in "goal free" browsing are not sufficient activities for formal learning settings and argued for careful consideration of what goals hypermedia assignments are to achieve. Most practitioners discover some middle ground, settling either on a guided discovery approach or lessons planned to achieve some specific objective but with the flexibility to take advantage of spontaneous learning opportunities. Interactive technology in general and hypermedia technology in particular have exacerbated the tension between assuring ourselves that students acquire specific knowledge and skills that experts find useful and providing opportunities for students to learn what to learn by making their own learning decisions.

As part of the ongoing evaluation of the Perseus project, questions of learner control were examined through responses of 350 students in 16 sections of courses at eight different institutions on questionnaires specific to their experience with the system. This paper provides evidence for giving both directed and undirected assignments rather than strictly one or the other.

The Perseus Hypermedia Corpus

The Perseus corpus is a HyperCard-based hypermedia information system that contains multi-media information about the ancient Greek world. The system includes Greek and English translations of ancient Greek literature together with various commentaries. The first commercial version (Perseus 1.0) includes the works of Pindar, Aeschylus, Sophocles, Herodotus, Thucydides, Pausanias, and Homer, as well as selections from Plutarch, Hesiod, and Appolodorus. The user can locate particular words in the text and have Perseus provide definitions. Pull-down menus at the top of the screen allow links to other texts, graphics, or various indexes. These are considered implicit links since they require users to initiate hypertext jumps rather than making selections from explicit buttons or anchors that are tied to specific information nodes. In addition to the texts, the project has collected approximately 16,000 images of more than 2000 objects and sites and Perseus 1.0 contains about 7000 of those images. These images represent the collocation of artifacts from a large number and variety of museums and archaeological sites.

A variety of tools make Perseus both usable and useful for analysis. For textual analysis, a morphological parser and dictionary with associated inverted indexes allow users to highlight a Greek word, identify its lemma and find definitions, and quickly see where that word is used in other works. Searches can also be conducted on the definitions themselves to allow users to analyze subtle meanings and styles within and across authors and works. Although a few individual tools exist for scholars to conduct such analyses today, Perseus is unique in providing both aggregation and extension—to the point of redefining how such research is conducted. For archaeological analyses, Perseus offers drawings of sites as they are thought to have existed at different periods of time. These drawings can be superimposed to provide a dynamic representation of developments over time at the sites. Icons on the drawings allow users to display photographs (digitized still images) or short videos (analog videodisc clips) of the sites as they appear today. Users can use the system to create their own interpretations of ideas by designing annotated "slide shows" or multi-media collages (see Crane, 1988; Crane & Mylonas, 1988; Mylonas, 1992 for fuller descriptions of the Perseus system).

Although each of these tools individually represents quantitative changes in what scholars and students can do, there is a synergy in their integration. For example, the literature student can jump to maps or site drawings to clarify and enrich concepts and ideas encountered while reading text. An encyclopedia, an atlas, and bibliographic citations are always available with a few moves of the mouse. Users also have the ability to create and store "paths" through the corpus or to enter notes and annotations. By developing paths, instructors can provide explicit tours through the corpus to illustrate key ideas. These paths can then be assigned to students individually or used in lectures to guide discussion. Students can create their own paths, which are submitted to instructors as interpretations or analyses of assigned problems or themes. A more self-directed use of paths is to facilitate the study of students' own learning by reviewing previous traversals of the corpus in much the same way as learners review passages in paper-based texts that they have highlighted with markers. Perseus empowers users to create new assignments and explorations, new interpretations, and new syntheses; it offers qualitative changes in what scholars and students can do. Assessing the effects of these new capabilities and the new goals they enable requires new and flexible approaches to evaluation and measurement and was a primary challenge of the evaluation effort conducted over the past five years (see Marchionini & Crane, 1994; Morrell, Marchionini & Neuman, 1993; Neuman, 1992 for other results of the evaluation effort).

Method

The methodology used for evaluating Perseus was multifaceted (see Marchionini, 1989, for the "CAT scan" approach to evaluation). In the first several years the main approach was formative (e.g., Flagg, 1990) to provide feedback to the designers. In the later years, more effort was focused on summative results that address how Perseus affects teaching and learning. Data collection methods included interviews, observations, automatic transaction logging, written questionnaires, and document analysis. This paper focuses on results from

questionnaires distributed to about 350 students in 16 classes at eight universities over a two year period. These sites represent four large research universities (three public and one private), and four small liberal arts colleges. Table 1 summarizes the different sites, the types of classes in which Perseus was used, and the type of assignment(s) given.

Table 1. Sites, Courses, Questionnaires Returned and Task Type 1991-93

School/Section	Course	Semester	#	Task/Type
1991-2				
1	Clas. world	S 92	33	follow paths (D)
3	Religion	S 92	10	follow path, write essay (M)
4	Literature	F 91	36	conduct lookups, create paths, write essay (U)
5	Religion	S 92	24	follow paths create paths (M)
1992-93				
6	archeology	F92	94	review/enrichment (U)
3	Fresh studies	F92	8	follow path, write essay (M)
5	Religion	S93	5	find info for essay (U)
2	Class/hist	F92	12	follow path, create path (M)
7	Greek lang	F92	3	translations, oral reports (U)
8	Greek lang	S93	9	create paths (U)
1/1	Clas. world	F92	38	follow paths (D)
1/2	Clas. world	F92	10	follow paths (D)
1/3	Clas. world	F92	13	follow paths (D)
1/4	Clas. world	Su92	9	follow paths (D)
1/5	Clas. world	S93	34	follow paths (D)
1/6	Clas. world	S93	8	follow paths (D)

The two-page questionnaire contained both open-ended and closed questions. The closed questions took the form of 5-point Likert scales and were grouped into three clusters: demographic, interface, and performance. All students in the 16 courses were asked to complete a questionnaire at a point in the semester after the Perseus-specific assignment(s) were due. The analysis of interest here was based on comparing questionnaire responses by type of assignment. The assignments instructors had devised were classified into one of three types: directed (D), undirected (U), and mixed (M). Directed assignments asked students to follow paths that were defined by the instructor to find specific information and complete a worksheet or answer short questions. Note that all directed assignments were given at one institution in sections of a course taught by two instructors who each developed distinct assignments. Undirected assignments varied but included using Perseus to assist in translating passages of Greek texts, conducting word analyses in texts to gather evidence for an interpretive essay about ancient Greek values, and creating paths that illustrated themes or concepts. When both types of assignments were given, the assignments were classified as mixed. In the mixed cases, directed path following activities preceded the undirected exploratory activities.

Results

In both years, no statistically reliable differences in students' ratings were found across students in different institutions (large research, large public, small private). Surprisingly, there were no statistically reliable differences due to amounts of previous computer experience or frequency of using Perseus. There were consistently high correlations between students' ratings of the interface (e.g., ease of learning, ease of use, number of times disoriented) and performance ratings (e.g., confidence in finding information, contribution to learning, value of system, satisfaction); but not between demographic ratings (e.g., age, previous computer

experience, frequency of Perseus use) and other clusters. Thus, one result of the studies is that the interface is more closely related to students' performance ratings than is previous experience or other demographic variables.

For the questionnaires collected over the 1991-1993 period, one-way analyses of variance across assignment type were performed. Table 2 presents summary data for the ANOVAs. For each of the questionnaire items, results of the ANOVA are shown either as NSRD (no statistically reliable differences) or in the ordered pair(s) of statistically reliable differences at the .05 level based on Tukey HSD post hoc analyses. When multiple pairs of contrasts are listed, they are given in order of smallest to greatest mean effect. For example, in 1992-93 students who did mixed assignments were statistically reliably more satisfied with their learning than those who did undirected assignments, and these differences were smaller than the statistically reliable differences between those who did mixed and directed assignments. The third column gives results for the combined data from both years. Since the 1991-92 questionnaire did not elicit some of the items on the 1992-93 questionnaire, those cells are blank. All effects are reported from most positive to least positive (e.g., for the frequency of getting lost, M>D means that the results were statistically reliably more positive for students in the mixed groups, i.e., they reported being lost less often than those in the directed groups).

Overall, the analyses illustrate that task type was associated with generally strong effects. In general, the mixed task type yielded more positive outcomes and ratings, with the undirected task type showing results that were almost as good in many cases. These results may reflect that students tended to spend more time using Perseus in undirected settings--i.e., when they direct their own learning. Furthermore, these results may be an artifact of the setting since students who did mixed assignments tended to spend more time using Perseus than those in other groups. This possibility is mitigated somewhat by the low of correlation between usage and performance ratings. The results could also be an artifact of the different collegiate settings or may suggest that students generally enjoy more positive experiences when they direct their own learning.

Table 2. ANOVA orderings across task types by questionnaire responses for 1992-3 and 1991-92

Question	1992-93 Responses	1991-92 Responses	1991-93 Combined
Use/Demographic Cluster			
Pfreq (freq of Perseus use)	M>U, M>D	U>M, U>D, M>D	M>D, U>D
Hours (using Perseus)	M>D, M>U		
Interface Cluster			
Learn (ease of learning P)	M>D, U>D	NSRD	M>D, U>D
Use (ease of using P)	U>D, M>D	NSRD	U>D, M>D
Docuse (usefulness of docum.)	NSRD	NSRD	NSRD
Images (quality of images)	M>D	U>M, D>M	NSRD
Lost (frequency)	U>D, M>D	NSRD	M>D, U>D
Recover (ease of recovery)	M>D, U>D	M>D	M>D, U>D
Performance Cluster			
Infoneed (needed info was in P)	D>U	D>U, D>M	D>U
Confid (confidence to find info)	NSRD	NSRD	NSRD
Assndif (difference of assign)	D>U, M>U		
Pcontrib (P contrib. to learning)	NSRD		
Infoamt (amt. of useful info)	M>U		
Value (learning value of time)	M>U, M>D		
Satis (satis. with learning)	M>U, M>D	NSRD	NSRD

Many of the results confirm what might be expected, but other results are more intriguing. Although these results must be interpreted with caution, the following interpretations seem

plausible. It seems reasonable that students who worked on mixed tasks or those who worked in exploratory ways spent more time using Perseus than those working on directed tasks. However, it was not the case that students in the directed groups used fewer features than those in the undirected groups (ANOVA for the number of Perseus features used across the three types of tasks yielded an F ratio of 17.04, p=.00, with students in the mixed groups using statistically reliably more features than either of the other two groups and students in the directed group using statistically reliably more features than the students in the undirected groups. Students in the mixed groups used an average of 8.3 features, while those in the directed and undirected groups used averages of 5.7 and 5.0, respectively. Intuition and experience argue that directed tasks are easier to learn and to execute than open-ended tasks. However, Perseus is a complex system and a single diversion from a path can lead users into unknown territory. Students who explore the system may actually expect to become lost, since they are not performing highly goal-directed tasks, and thus may rate ease of learning and use less critically than those who viewed the assignment in a more linear fashion. The differences in assessing ease of learning and use may reflect the fact that students in the directed groups were all from one site, where access to workstations was limited and laboratory assistance was minimal. As is reasonable, the results for frequency of getting lost and ease of recovery parallel those for learning and ease of use. Results for quality of images are mixed: all students rated the images quite highly, and there is little variability across or within groups.

Results for the performance questions illustrate how expectations and task experience combine during learning. Students in the directed groups rated the likelihood that the information they needed was in Perseus reliably higher than the other two groups, since they followed defined paths and accomplished tasks that required them to locate specific information that they knew the designers of the assignments had verified would be there. Students completing more open-ended assignments, however, had to define their own information needs and then locate relevant information by using Perseus finding aids. These students not only worked without knowing in advance whether the appropriate information would be there, they were also subject to the many ways information seeking can go awry during the definition-of-needs step as well as when using such Perseus tools as indexes and word searches. While it is somewhat surprising that directed students did not rate the amount of useful information more highly, this rating may reflect students' lack of awareness of how to locate information beyond that to which they had been directed.

Ratings for how different Perseus assignments were from usual assignments may suggest that students who worked on undirected tasks viewed them as similar to paper-based tasks in which they explored a variety of books or articles for information on topics. Directed students may have viewed the Perseus assignment as more typically linear and pedantic.

Finally, and most importantly, those students who used Perseus in a variety of ways rated the value of the time they spent with Perseus more highly than students in either of the other two task groups. Likewise, they were more satisfied with their learning than those in the other groups. Discovering the proper mix of tasks is clearly one of the challenges of teaching, and these results seem to reinforce a "variety is the spice of learning" view of instruction.

Discussion

As with most issues of pedagogy, the problem of how much learner control is best for students using hypermedia requires relativistic rather than absolute solutions. Although people are adaptable and will learn under most conditions, high levels of learner control yield the best results when learners have good prerequisite knowledge upon which to build or have large amounts of time and patience to invest in learning. Flexible learning environments such as Perseus may be designed primarily to support self-directed learning but also must provide mechanisms such as the path tool that allow students to follow carefully designed instructional paths.

Rather than simple variety of activities, the fact that mixed assignments began with directed and then allowed self-directed exploration suggest that a staged progression of increasing learner control is superior to either the "cookbook" or "sink or swim" methods. This conclusion is due

both to the psychology of learning and to the nature of the electronic medium. The former predicts that learner control is more engaging and thus more motivating for experienced learners. Moreover, new type of challenges in the form of assignments serves as stimulation for continued engagement--a self-reinforcing process. The latter predicts that learning within a complex system is distinct from using it to accomplish tasks and that progressive disclosure or minimalist instruction may be the best way to apply such systems (e.g., Carroll, 1990). Since systems such as Perseus are highly complex to learn to use and to actually use after system learning has taken place (there are a multitude of features and alternative tools for accomplishing any task), an incremental experience can minimalize overload and frustration. Taken together, these two notions imply that if hypermedia systems are to be effective for learning, they should be applied for sustained periods with varied assignments that are staged from directed to undirected progression. Variety is the spice of learning. However, the tension between learner directed and teacher directed learning is best managed by insuring that the variety is not random.

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