Perceived Disorientation and Incidental Learning in a Web-based Environment:

Internal and External Factors

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Amy L. Baylor, Ph.D.

Instructional Systems Program

Department of Educational Research

Florida State University

307 Stone Building

Tallahassee, FL 32306

Phone: (850) 644-5203

Fax (850) 644-8776

Email: baylor@coe.fsu.edu

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ABSTRACT

In a four-factor MANOVA design, this exploratory study experimentally investigated the influence of navigation mode (linear, nonlinear), distracting links (presence, absence), sensation-seeking tendency (high, low), and spatial-synthetic ability (high, low) on perceived disorientation and incidental learning (accuracy of main point, example generation) in web navigation. Seventy-five participants completed a search task to find the location of five sentences within a nine-page web-based passage. Regarding disorientation, a moderately large effect size indicated that those in the linear navigation mode were more disorientated than those in nonlinear navigation mode. Contrary to predictions, there were no effects on disorientation for spatial-synthetic ability and sensation seeking tendency. Regarding incidental learning, example generation was facilitated by sensation seeking tendency and the absence of distracting links; main point score was facilitated by spatial-synthetic ability. Further, a moderately large effect size indicated the role of the nonlinear navigation mode in facilitating higher main point and example generation scores. Disorientation was negatively correlated with both example generation and main point score.

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Introduction

Given the rapid growth of the Internet and the commensurate need to design improved systems for participant access and learning, this study experimentally investigated the role of internal and external factors on disorientation and incidental learning in World Wide Web navigation. Disorientation can be conceptualized in terms of a user's perception of his/her uncertainty in location. A common phenomenon on the World Wide Web is for a participant to become sidetracked by other links and become disoriented when seeking a particular location. From the participant's perspective, did s/he make the right choice or will s/he have to back-track? Did she temporarily ignore her original intent because she has a high need for novelty and stimulation? What insights about the content did s/he gain? What is her spatial-synthetic representation of the web-site? Additionally, much of the inconvenience of disorientation may be perceptual. Like waiting in line at the grocery store, where some people become livid while others use it as a chance to start up a conversation, disorientation on the web may be considered as exciting or as an annoying distraction that prevents the participant from staying on-task. Further, additional insights may be gained through disorientation that otherwise may not be realized, such as learning of a special price on crabmeat when mistakenly in the wrong aisle.

Since many people spend significant time figuratively "surfing" through web-sites looking for information, it is important to investigate what is learned incidentally through this process. What information is ascertained along the way? What personal factors and features of the web-site contribute to incidental learning?

Review of literature

Starting with an overview of incidental learning and disorientation in web navigation, this section will discuss the potentially influential role of ***external factors*** (navigation mode and distracters) and ***internal factors*** (spatial-synthetic ability and sensation seeking tendency). Given the limited empirical research of learning from the Web and the similarity of it with open-ended learning environments such as hypertext (e.g., both have the features of non-linearity, the presence of links, and flexible navigation), the review of literature will include findings from hypertext research.

Incidental Learning and Disorientation in Web Navigation

From the user's perspective, an open-ended learning environment (such as the Web or hypertext) may facilitate learning in two stages: information-seeking and knowledge acquisition (Chou & Lin, 1998). For basic information-seeking, it provides a large amount of information that can be represented in multiple ways for the learner to selectively browse. If the learner takes advantage of the information structure, s/he is facilitated in the process of exploring and finding the information needed. After this initial information is found, the learner must integrate the new knowledge with existing knowledge through knowledge acquisition through the processes of accretion, restructuring and adaptation (Chou & Lin, 1998). Along the way, additional information that is not task-related may be obtained and retained through the process of incidental learning.

With regard to incidental learning, Eysenck's (1974) classic experimental psychology study showed that when subjects were unexpectedly asked to recall words that were previously presented, better recall was associated with deeper processing. More recently, with computer-based learning, Rieber (1991) looked at the positive effects of animation on incidental learning in science principles. Schank & Cleary (1995), citing significant empirical evidence in cognitive science, discussed the value of learning informally when the learner is “ not really trying.” They proposed an Incidental Learning Architecture for computer-based systems where course designers construct situations in which factual knowledge can be naturally acquired through otherwise pleasurable activities. Given the importance of researching what is learned incidentally through computer-based systems, this study investigated the incidental learning of text in a web-based environment. Specifically, incidental learning is conceptualized in two ways in this study: 1) from the ***macro level of text processing*** as one’s effectiveness at figuratively “ getting the gist” of the web-site content and developing a schematic mental representation to determine the main point; 2) ***from the micro level of text processing*** as one’s effectiveness at generating and recalling examples from the content. The distinctions between macro and micro levels of processing are made for the purpose of describing this study.

Disorientation in navigation is defined here as a user’s perception of his/her uncertainty in location. While disorientation has been described as a major problem with hypertext use (e.g., Conklin, 1987; Jonassen & Grabinger, 1989; Thuring, Hannemann & Haake, 1995), some level of disorientation may be a good thing for the learner (Mayes, Kibby, & Anderson, 1990) as it forces her to use exploratory learning and to engage with and create a personal schematic representation of the content. Consequently, while the implementation of a three-dimensional spatial environment is technically feasible and would solve some disorientation problems for the learner, the use of such an environment with its visualization facilitation may provide the learner with too much information about ***locating*** information without letting the user discern the structure and ***meaning*** of the information.

Regardless, disorientation is a problem in terms of learning in open-ended learning environments in terms of both the navigational issue from the user's perspective and also the external geography of the web-site (e.g., if it is too complex for the user to grasp/map) (Mayes, Kibby & Anderson, 1990). Consequently, both internal (e.g., relative to the person) and external factors (e.g., pertaining to the web-site) should be considered.

External Factors: Web-site Navigation Mode and Presence of Distracters

In terms of navigation mode, two contrasting instantiations are linear or nonlinear. In a linear navigation mode, the user moves through the web-site sequentially and is only allowed to move forward or backward through the content; thus, the sequence of web pages is controlled by the web-site. A non-linear navigation mode is where the user has options to "jump" to any location within the web-site at any time, providing more flexibility and control for the user.

An advantage of a nonlinear navigation mode (typical of hypertext-based systems) is that a learner could navigate in a personally-meaningful way to access information when and how it is best anchored to his/her knowledge structure (Jonassen, 1992). However a disadvantage is that the nonlinear mode may not have the coherence that would be provided when the learner is forced to process the information in a more systematic way (from beginning to end). Specifically, in the nonlinear mode, the learner may not be able to determine how the overall content is globally represented. This problem is particularly problematic in web-based environments (Foltz, 1996; Kommers & Lanzing, 1997). Along this line, Whalley (1989) implies that a certain level of linearity is necessary to impose order on hyperspace, suggesting that it would be important in the nonlinear condition for subjects to know where they are relationally in the web-site.

In traditional forms of navigation one must determine her spatial position in relation to landmarks or astral location to decide on the means of moving toward the goal, which is straight ahead. Landow (1989) describes navigation as the art of controlling the course of a plan (or ship) that presupposes a spatial world. The feeling of being lost while navigating in general may result from a lack of connection among physical representations of the world and the user's position within it with the user's mental representations of the world (Wickens, 1990). This suggests the need for some sort of mapping or landmarks to serve as cues.

In terms of the role of non-essential hyperlinks, they may either serve as distracters (by confusing the learner and taking him off-task) or as visual cues/ landmarks. By definition, the purpose of a distracter is to focus attention away from the main content and re-direct it. Examples of common distracters on the Web are advertisements, which are strategically placed and designed to capture the user's attention to click on them for more information, thereby diverting him/her from the current task.

Regarding incidental learning, depending on their content, the distracters could also serve as seductive details (e.g., Harp & Mayer, 1998) by increasing interest in the content at the expense of providing unnecessary information for the reader and activating inappropriate schema. In contrast, when they are not directly related to the content of the web-site passage, the distracters could also direct the user's attention to his/her location by providing incongruous information. Overall, then, two external web-site factors include navigation mode (linear vs. nonlinear) and the presence/absence of non-essential links, or distracters.

Internal Factors: Sensation-seeking Tendency and Spatial-synthetic Ability

Sensation-seeking tendency is a general preference for high or low levels of sensory stimulation, first described by Zuckerman (1979) who believed it is based in a strong genetic predisposition and it was later confirmed as a valid individual difference (e.g., Ridgeway & Russell, 1980). High sensation seekers tend to seek excitement and thrills, are more uninhibited, and easily bored as compared to low sensation seekers, who prefer tranquility. High sensation seekers are also more tolerant of stress and thereby may not only mind being disoriented, but actually may seek out distractions and new experiences to get off-task. Further, high sensation seekers may learn more from an environment with high stimulation. Consequently, a person low in sensation-seeking tendency may prefer a more streamlined approach to navigation with no distracting links whereas a person high in sensation-seeking tendency may prefer more varied navigational features with a greater number of available links or distracters. While sensation seeking is a valid construct in personality and clinical psychology, it has not previously been applied to considerations for hypermedia navigation.

While much work has been done to consider the role of field-independence and field-dependence as a cognitive style (see Witkin, Moore, Goodenough & Cox, 1977) in open-ended environments (e.g., Stanton & Baber, 1994)), little attention has been given to the potential role of spatial-synthetic ability. Spatial-synthetic ability is defined here as one's ability to perceive the whole picture from only the parts and is involved in information processing. Given a person's need to discern the "gestalt" (i.e., big picture) to successfully navigate and learn, it seems that a person's spatial-synthetic ability would be related to her ability to navigate and learn in an open-ended learning environment. Consequently, both sensation seeking tendency and spatial-synthetic ability have potential roles as internal factors influencing disorientation and incidental learning. Given that these two internal variables have not been previously investigated with respect to hypermedia or web navigation, this is primarily an exploratory study.

Research Questions

The seven research questions are listed below, grouped by dependent variable.

Perceived disorientation

1. Do external web-site features (navigation mode, distracters) affect perceived disorientation in a web-based environment?
2. Do internal factors (sensation seeking tendency, spatial-synthetic ability) relate to perceived disorientation in a web-based environment?
3. How do these external and internal factors interact to affect perceived disorientation in a web-based environment?

Incidental Learning

4. Do external web-site features (navigation mode, distracters) affect incidental learning in a web-based environment?
5. Do internal factors (sensation seeking tendency, spatial-synthetic ability) relate to incidental learning in a web-based environment?
6. How do these external and internal factors interact to affect incidental learning in a web-based environment?

Disorientation ←→ Learning

7. What is the relationship between disorientation and incidental learning in a web-based environment?

Methods

Participants

Seventy-five volunteer participants were recruited from Internet listings that advertised the study, drawing from a diverse nationwide population. Prior experience navigating the Web was a requirement for participation in the study. Participants were compensated for participation. Of the seventy-five participants, 79% were white and 21% non-white (including primarily Asian and Hispanic). The mean age was 30.47 with a standard deviation of 1.26. Of the 74 participants reporting gender, 34 (46%) were female and 40 (54%) were male.

Procedures

The entire procedure occurred online. First, information was collected regarding the participants' ***prior knowledge*** of the web-site passage content (e.g., uses of the Internet for education) and general ***systems knowledge*** regarding use of technology and the Internet. For each participant, the software developed for the experiment randomly selected one of four web-sites to navigate. The four web-sites reflected different instantiations of the two external factors (e.g., linear + distracters; linear + no-distracters; nonlinear + distracters; nonlinear + no-distracters). See Figure 2 and Figure 3 for screen shots of the web-sites. The four web-sites all contained nine web pages of identical text that comprise a passage on Internet use for education and were designed according to usability development principles. The text was adapted from information at Andy Carvin's web-site at http://edweb.gsn.org/web.intro.html. Since the structure of text generally influences a person's ability to organize its content, headings were included to guide the reader through the text. As described by Lorch and Lorch (1995) the presence of headings in a text leads to better summaries (Brooks, Dansereau, Spurlin, & Holley, 1983), better outlines (Brooks et al.,1983; Dee-Lucas & DiVesta, 1980), and better memory for the main points of a text (Spyridakis & Standal, 1987). Software was developed in Perl to track the participant's path through the web-site in terms of total time spent, time spent on distracting links, and the number of distracting links selected.

The ***linear navigation mode*** was operationalized by requiring the participant to proceed through the web-site passage similar to reading a textbook, only able to move forward and backwards. While this is a somewhat artificial treatment, it was designed to maximally contrast with the nonlinear mode of navigation. In the nonlinear navigation mode, the participant had immediate access to all pages at any given time through a navigation bar on the left-hand column.

The ***presence of distracters*** was operationalized by including (or not including) six distracting links placed throughout the nine pages of the web-site. The six distracting links were designed to figuratively "seduce" the participant to click on the link (e.g., David Letterman's Top Ten, jokes, Dilbert cartoons) and encourage off-task behavior. Each distracter was comprised of a small picture with a link indicating to "Click here to ?" The no-distracter condition did not contain any distracters but was otherwise identical.

All participants had the same task: to successfully find the passage headings under which each of five statements were located within the nine-web-page online passage. The instructions were as follows:

> Please write down the heading of the web-site page where the following statements are found. The statement may not be an exact match to the sentence on the web site, but should convey the same message. *When you have completed this page, select the "Questions" link on the left side of the web page. You will be provided with a form where you can fill in the correct heading for each statement. Click Submit when you believe your answers are correct. If they are incorrect you will get to re-try until you do answer them correctly.
>
> 1) The majority of schools lack the hardware needed just to get connected in the first place.
> 2) Tim Berners-Lee developed the World-Wide Web.
> 3) CERN is the name of one team of researchers that came up with the HTML standard.
> 4) Lycos is the name of a server at Carnegie Mellon University that will search out every know document on the Web.
> 5) Interactivity has become a buzzword for the learning process.

Participants could access the five statements via a link titled "Questions" from any page on the web-site. In determining the appropriate heading location, the participants did not have open-ended access to the Internet; the toolbars were de-activated and they were limited to the pre-defined web pages for the experimental web-site.

Following successful completion of this search task, which took approximately 25 minutes in pilot testing, the participant was profiled online according to the following two psychological dimensions: ***preference for sensation-seeking behavior*** and ***spatial-synthetic ability***, which served as independent variables representing two internal factors. To assess sensation-seeking preference, participants answered a battery of questions pertaining to preference for sensation-seeking tasks (from Zuckerman, 1979). The complete Zuckerman Sensation-seeking Scale has been shown to be reliable (Ridgeway & Russell, 1980); however it contains 72 items which is problematic given time considerations. Consequently, the short version of the scale was used, which consists of 34 questions with paired statements from which the participant would select the one statement best describing him/her. For example: A) I would prefer living in an ideal society where everyone is safe, secure, and happy; or, B) I would have preferred living in the unsettled days of our history. The mean score of the participants was 18.50 (sd=5.83) with a possible range of 0-34. To assess spatial-synthetic ability, participants completed the Street Test (Street, 1931), a thirteen-item gestalt completion test. The Street Test has been shown to measure aspects of field-independence (Gough & Olton, 1972), and perceptual abilities (Bethscheider, 1988). This instrument assessed spatial-synthetic ability by requiring the participant to mentally construct a whole picture from a partially-represented figure, such as a figure of a bearded man, a cat, or a locomotive. See Figure 4 for two examples. The mean score of the participants was 7.36 (sd=2.52) with a possible range of 0-13. Next, the level of participant disorientation was determined from ten Likert-scale questions from Beasley

& Waugh's 10-item Non-Linear Media Disorientation Assessment instrument (Beasley & Waugh, 1995).

In terms of attributions for disorientation, participants were asked the following question:

> Consider the times when you felt disoriented during the task. Overall, do you attribute your feelings of disorientation to your self or to the web-site?
>
> (on a scale with 1 representing to the self and 5 representing to the web-site.)

This question served to assess to what extent participants attributed (i.e., blamed) navigation problems on the web-site as opposed to themselves. Next, participants were asked to describe in an open-ended question the strategies that they used during the search task. Finally, incidental learning measures consisted of ***explaining the main point*** of the passage and ***generating examples*** pertaining to the passage, specifically to list as many benefits of using the Internet for education as possible, according to the passage on the web-site.

<u>Scoring</u>

For the ***example generation question***, the student received one point for each correct answer or separate idea that was stated in the passage. If there was more than one benefit in the sentence, then s/he received a point for each benefit. The experimenter and another person coded a sample of the data until a criterion of at least 85% agreement was reached to establish inter-rater reliability. Once there was agreement in the coding methods, the experimenter performed the coding. The range of scores was 0-9, with the mean as 3.34 (sd=1.97). For the ***main point question***, the students' written explanation of the main point of the passage were scored on a 1-5 scale, with a representative answer receiving a "1" as "It provides a general discussion about the web" and a representative answer receiving a "5" as "It analyzes the possibilities the web offers to educators and its importance as a learning tool." Credit was given according to how well the participant's answer conveyed the main point of the passage. The experimenter and another person coded a sample of the data until a criterion of at least 85% agreement was reached to establish inter-rater reliability. Once there was agreement in the coding methods, the experimenter performed the coding.

In terms of self-reported navigational strategies, they were coded according to Astleitner & Leutner's (1985) distinction among scan, search and wander, and also according to high vs. low mental effort. The experimenter and another person coded a sample of the data until a criterion of at least 85% agreement was reached to establish inter-rater reliability. Once there was agreement in the coding methods, the experimenter performed the coding.

Research Design

The study was originally designed as a four-way MANCOVA design with system knowledge as the covariate because systems knowledge has been shown to directly affect participants' competencies at navigation (Hill & Hannafin, 1996). However, systems knowledge scores were very high (M=4.08 on five point scale) and positively skewed, precluding the value of using them as a covariate. Consequently, the experimental design was comprised of a four-factor (2x2x2x2) MANOVA design. The two external (between-subjects) factors were **navigation mode** (linear, nonlinear) and **distracters** (presence, absence). The two internal (within-subjects) factors were **sensation seeking tendency** (high, low) and **spatial-synthetic ability** (high, low). See Figure 1 for a graphic view of the model. While this is a complex model, a multivariate approach was selected in order to consider the inter-relationships of the factors. Alpha level was set at p=.05 given the exploratory nature of the study.

Results

The main analysis was a four-factor (navigation mode: linear, nonlinear; distracters: presence, absence; spatial-synthetic ability: high, low; and, sensation seeking tendency: high, low) MANOVA with three dependent variables, one representing perceived disorientation and two representing incidental learning (accuracy of main point, example generation). Spatial-synthetic ability and sensation seeking tendencies were blocked into high and low groups by a median split. Table 1 lists a summary of the MANOVA results and Table 2 lists the means, standard deviations, and effect sizes. Note that effect sizes will be considered in the results as a valid measure of effect where appropriate (e.g., Olejnik & Algina, 2000).

Perceived Disorientation

Level of disorientation was determined from the ten-item Non-Linear Media Disorientation Assessment instrument (Beasley & Waugh, 1995) as described earlier. With this instrument, disorientation scores could potentially range from — 20 (very orientated) to +20 (very disoriented). For participants in this study, the range was — 20 to +11 with a mean of — 11.84 (sd=6.28), indicating that they overall tended to be oriented. As expected, participants' disorientation scores correlated negatively to systems knowledge (r= -.253, p<.05), interest in content (r=-.351, p<.005), and confidence in navigating (r=-.605, p<.0001).

First, in terms of ***external factors and disorientation***, while the MANOVA main effects for navigation mode and distracters were not significant for the total disorientation score, those in the linear navigation mode were more disoriented (M= -10.63) than those in nonlinear condition (M= -13.58, effect size =.47). Note that the moderately large effect size (.47) is meaningful, even though not statistically significant. Further, those in the linear navigation mode happened to have higher prior content knowledge (M=3.75) than those in nonlinear condition (M=3.32, p=.09), yet, as mentioned previously, they were still overall more disoriented with the web-site.

Second, in terms of ***internal factors and disorientation***, there was no evidence that preference for sensation-seeking behavior and spatial-synthetic ability influenced perceived disorientation. In terms of the role of prior knowledge, there was not a statistically significant correlation between prior knowledge and disorientation (r = -.172, p>.10). In terms of attribution for disorientation, the average attribution score across participants was 3.29 (sd= 1.22), indicating that they tended to attribute disorientation to the web-site rather than to themselves. Interestingly, females reported more confidence navigating the site than males (M=4.68 vs. M=4.26, p=.001), yet they also reported more overall disorientation with the site (M=10.52 vs. 13.24; p=.07). There were no statistically significant differences by gender in systems knowledge, visual spatial scores, or confidence in general in navigating.

Incidental Learning

First, in terms of ***external factors and incidental learning*** the presence of distracters had a negative effect on both incidental learning measures. Regarding example generation, the four-factor MANOVA (listed in Table 1) indicated that there was a significant main effect for distracters (F=3.995, p<***.05***). Specifically, participants in web-sites with no distracters performed better in example generation (listing more relevant benefits) (M=3.90) than those in a web-site with distracters (M=2.76). Regarding accuracy of main point, although the MANOVA indicated no significant main effects for distracters, there was a moderate effect size (.46) where those in web-site without distracters performed better (M=3.55) than those in web-sites with distracters (M=3.03). In terms of the role of navigation mode, less substantial effect sizes (>.30, see Table 2) indicated the possible negative effect of the linear navigation mode on both incidental learning measures.

Second, in terms of ***internal factors and incidental learning*** the MANOVA indicated a significant difference (F=4.364, p<.05) in main point scores between those with high spatial-synthetic scores (M=3.51) and low spatial-synthetic scores (M=3.06), thereby indicating that spatial-synthetic ability facilitates discerning the main point. The MANOVA also indicated a significant difference (F=4.901, p<.05) in example generation scores between those with high sensation seeking tendency (M=3.61) and low sensation seeking tendency (M=3.13) where sensation seeking tendency facilitated generating examples; however, the effect size of .24 was only marginal. As expected, prior knowledge was correlated with incidental learning measures: (example generation: r= .262, p<.05; and main point: r=.395, p<.01).

In terms of the relationship between incidental learning and disorientation, the total disorientation score was negatively correlated with participants' main point score (r= -.247, p<.05) and example generation (r= -.223, p=.06). Additionally, it was found that those that attributed their disorientation to self had significantly higher main point scores (M=3.88) than those attributing it to website (M=3.06, p=.018). A t-test of participant self-reported navigational strategies showed that those strategies using more mental effort (e.g., controlled reading, focus on headings and/or key words) were related to the person attributing disorientation to themselves (M=2.70, N=20) as opposed to those using strategies with less mental focus (e.g., relying on memory, skimming text, or trial & error) who tended to attribute disorientation to the web-site (M=3.39, N=41, p=.04).

Discussion

To discuss the results, each research question will be considered separately.

<u>1. Do external web-site features (navigation mode, distracters) affect perceived disorientation in a web-based environment?</u>

Possibly, for navigation mode. A moderately-high effect size indicated that participants reported more disorientation with the linear navigation mode as compared to the nonlinear navigation mode. This indicates that users are more used to and more comfortable with the nonlinear format of web-sites than when forced to navigate in a linear configuration. This finding is in-line with findings from Lai & Waugh (1994) where explicit menus that showed the hierarchical structure of the content of the web-site produced better search performances in most cases and also were preferred by the learners. However, this result must be interpreted cautiously given that the MANOVA was not significant for the main effect of navigation mode.

<u>2. Do internal factors (sensation seeking tendency, spatial-synthetic ability) relate to perceived disorientation in a web-based environment?</u>

No. Contrary to predictions, there were no relationships between the internal factors of sensation seeking tendency and spatial-synthetic ability with perceived disorientation. In terms of spatial-synthetic ability, it would have been expected that those high in spatial-synthetic ability would have been less disoriented than those low in spatial-synthetic ability; however, this was not supported. Perhaps this can be explained by the similar intuitive appeal for considering the role of field-dependence in web navigation as it was shown to account for differences in differentiating the parts from the field in other domains; however, results were inconclusive on its effects on web-navigation search performance (e.g., Chou & Lin, 1998). Similarly, the results were inconclusive with the role of spatial-synthetic ability in this study. Perhaps as Landow (1989) states, " the analogy of navigation, with its associated and possibly misleading spatial assumptions has become widespread in writings on hypertext." (p. 50) Or, as Landow (1989) notes, hypertext environments are not entirely experienced as a spatial world because moving through hypertext links takes relatively the same amount of time to traverse. He supports this assertion by stating that all linked texts are experienced as lying the same “ distance” from the point of origination. However, this is somewhat inaccurate given that when there are multiple links to get to one location, it does take longer time. It becomes more complex, though, when considering the sometimes unpredictable delays in loading a web page.

Interestingly, the expected role of prior knowledge in facilitating orientation was not supported. It would be expected that the more that participants know about the web-site content, the less likely they are to get disoriented (Hill & Hannafin, 1997). However, there was not a statistically (or practically) significant correlation between prior knowledge and disorientation. Further, those in the linear navigation mode happened to have marginally significant higher prior content knowledge than those in nonlinear condition, yet they were still overall more disoriented with the site. This indicates that navigation mode may be a greater factor than prior knowledge in influencing orientation.

<u>3. How do these external and internal factors together affect perceived disorientation in a web-based environment?</u>

There was no evidence that the external and internal factors together are related to perceived disorientation. It was expected that there would be an interaction of sensation seeking tendency with distracters, where those high in sensation seeking would be less disoriented on a web-site with distracters whereas those low in sensation seeking would be less disoriented on a web-site with no distracters; however, this was not supported. It was expected that there would be an interaction of spatial-synthetic ability with navigation mode, where those with high spatial-synthetic ability would be less oriented in the nonlinear web-site than those with low spatial-synthetic ability; however, this was also not supported.

4. Do external web-site features (navigation mode, distracters) affect incidental learning in a web-based environment?

Yes. As expected, results indicated that the presence of distracters negatively affected example generation and to a lesser extent, the linear navigation mode negatively affected both main point scores and example generation. First, the presence of distracters negatively affected scores on example generation. Perhaps the distracting links distracted the participant from focusing on and then later recalling passage content. With the distracters present, it appears that participants put even less thought into evaluating what the possible benefits were and/or inferring them from the passage. Second, in terms of both main point scores and example generation, those in the nonlinear navigation mode performed better than those in the linear mode as indicated by moderate effect sizes (.35 and .33); however, the MANOVA main effect was not significant in either case**.** Perhaps those in the nonlinear were in a mind-set of paying more attention to the schema of the site because they had more options, thereby focusing more and developing a metacognitive awareness of the organization of the site. Further, in the nonlinear mode, they had to be consciously more on-task all the time, so they could more readily encode the main point of the passage as well as anchor the benefits for later recall.

5. Do internal factors (sensation seeking tendency, spatial-synthetic ability) relate to incidental learning in a web-based environment?

Yes. Results indicated that sensation seeking tendency is positively related to example generation and spatial-synthetic ability is positively related to main point score. From a micro-level of processing, perhaps sensation-seeking tendency facilitates example generation since seeking variety and paying attention to details is associated with idea generation. From a macro-level, higher spatial-synthetic ability was associated with greater accuracy at explaining the main point. The ability to see the whole from parts seems to facilitate the text-processing aspect of discerning the main point, to figuratively get “ the gist” of the passage across all navigational conditions. In both measures of incidental learning, it is of interest whether these findings apply to text processing in general, or are specific to web-based environments containing text.

6. <u>How do these external and internal factors together affect incidental learning in a web-based environment?</u>

The external and interact factors do not appear to interact to affect incidental learning, but further study is necessary. While there were no statistically significant interactions with the internal and external factors in terms of incidental learning, there were two marginally significant interactions (navigation mode X synthetic-spatial ability X sensation seeking tendency; and, navigation mode X sensation seeking tendency) which should be investigated through replication of the study with a larger sample size.

7. <u>What is the relationship between disorientation and incidental learning in a web based environment?</u>

Perceived disorientation had a strong negative effect on participants’ main point score and a moderate-to-strong negative effect on example generation. This indicates that a person’s belief that s/he is less oriented to the web-site is directly related to his/her performance on incidental learning measures.

Conclusion

Given that this study was primarily exploratory in nature, these results should only be considered as preliminary. It is important to note that the web-site was not designed for instructional purposes but was designed to present information; thus, the participant's task involved searching, with learning the information only as incidental. Learning is a much more complex activity that cannot just be equated with information retrieval, navigation, or memorization alone (Thuring, et al. 1995). Researchers investigating hypertext have found that the users' task is a key factor regarding evaluating findings of usability (Chen & Rada, 1996; Nielsen, 1990). If a person's task is to search for information in a hypertext-based environment (such as the Web), s/he may show lower comprehension on general knowledge of the text (Foltz, 1996). Further, the web-site was basically a passive medium with the text-based passage, and as Spiro & Jehng (1990) have noted, learners must play an active role to learn in such an environment.

In terms of disorientation, the results suggest that the linear mode may be more disorientating than the nonlinear navigation mode based on a moderately large effect size. There is a negative relationship between learning and perceived disorientation in a web-based environment. To synthesize these findings in terms of incidental learning of web-based text from a macro and micro perspective, see Figure 5. From the macro-perspective, a learner can more readily discern cues and figuratively "get the gist" (i.e., the main point) with greater spatial-synthetic ability. From the micro-perspective, a learner can more readily list examples from the content with greater sensation seeking tendency and the absence of distracters. Although not significant as a main effect in the MANOVA, the nonlinear navigation mode is preferable over the linear navigation mode for both measures of incidental learning.

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Table 1
MANOVA Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F
Navig. Mode	Accuracy of Main Point	1.321	1	1.321	.966
	Example Generation	2.646	1	2.646	.809
	Disorientation	48.696	1	48.696	1.180
Distracters	Accuracy of Main Point	1.857	1	1.857	1.358
	Example Generation	13.064	1	13.064	3.995*
	Disorientation	81.350	1	81.350	1.971
Synthetic-spatial	Accuracy of Main Point	5.970	1	5.970	4.364*
	Example Generation	5.721E-02	1	5.721E-02	.017
	Disorientation	51.913	1	51.913	1.258
Sensation seeking	Accuracy of Main Point	.665	1	.665	.486
	Example Generation	16.026	1	16.026	4.901*
	Disorientation	5.721E-02	1	5.721E-02	.001
Navig. Mode X Distracters	Accuracy of Main Point	2.877	1	2.877	2.103
	Example Generation	.193	1	.193	.059

	Disorientation	9.177	1	9.177	.222
Navig. Mode X Synthetic-spatial	Accuracy of Main Point	2.227	1	2.227	1.628
	Example Generation	4.516E-02	1	4.516E-02	.014
	Disorientation	5.707	1	5.707	.138
Distracters X Synthetic-spatial	Accuracy of Main Point	.408	1	.408	.298
	Example Generation	2.433	1	2.433	.744
	Disorientation	52.657	1	52.657	1.276
Navig. Mode X Distracters X Synthetic-spatial	Accuracy of Main Point	.246	1	.246	.180
	Example Generation	1.288	1	1.288	.394
	Disorientation	17.668	1	17.668	.428
Navig. Mode X Sensation seeking	Accuracy of Main Point	.122	1	.122	.089
	Example Generation	10.417	1	10.417	3.186[m]
	Disorientation	6.635	1	6.635	.161
Distracters X Sensation seeking	Accuracy of Main Point	.255	1	.255	.186
	Example Generation	2.190	1	2.190	.670
	Disorientation	80.835	1	80.835	1.958
Navig. Mode X Distracters X Sensation seeking	Accuracy of Main Point	.131	1	.131	.096
	Example Generation	2.040	1	2.040	.624
	Disorientation	10.503	1	10.503	.254
Synthetic-spatial ability X Sensation seeking	Accuracy of Main Point	.331	1	.331	.242
	Example Generation	10.076	1	10.076	3.081[m]
	Disorientation	9.421	1	9.421	.228
Navig. Mode X Synthetic-spatial ability X Sensation seeking	Accuracy of Main Point	.479	1	.479	.350
	Example Generation	12.411	1	12.411	3.795[m]
	Disorientation	.462	1	.462	.011
Distracters X Synthetic-spatial ability X Sensation seeking	Accuracy of Main Point	.820	1	.820	.599
	Example Generation	.243	1	.243	.074
	Disorientation	9.740	1	9.740	.236
Navig. Mode X Distracters X Synthetic-spatial X Sensation seeking	Accuracy of Main Point	.581	1	.581	.425
	Example Generation	1.604	1	1.604	.490
	Disorientation	16.564	1	16.564	.401
Error	Accuracy of Main Point	57.448	42	1.368	
	Example Generation	137.345	42	3.270	
	Disorientation	1733.712	42	41.279	
Total	Accuracy of Main Point	681.000	58		
	Example Generation	876.000	58		
	Disorientation	10803.000	58		
Corrected Total	Accuracy of Main Point	78.086	57		
	Example Generation	213.655	57		
	Disorientation	2233.603	57		

* ***p***< .05

[m] .05< ***p*** <.10 (marginally significant)

Table 2
Mean differences, standard deviations and effect sizes

	Disorientation[a]	Example Generation	Main Point
Navigation condition			
Linear	-10.63 (6.69)	3.00 (1.67)	3.10 (1.26)
Nonlinear	-13.58 (5.34)	3.64 (2.21)	3.50 (.92)
Effect size	0.47	-0.33	-0.35
Distracters			
Absence	-12.83 (5.98)	3.90 (1.69)	3.55(1.09)
Presence	-11.00 (6.52)	2.76 (1.98)	3.03 (1.14)
Effect size	-0.30	0.59	0.46
Spatial-synthetic			
Low	-11.50 (6.61)	3.19 (1.69)	3.06 (1.07)
High	-12.17 (6.02)	3.50 (2.26)	3.51 (1.20)
Effect size	0.11	-0.15	-0.40
Sensation seeking			
Low	-12.12 (6.47)	3.13 (1.70)	3.33 (1.03)
High	-12.17 (6.15)	3.61 (2.19)	3.26 (1.29)
Effect size	0.010	-0.24	0.07

[a] Note that a higher disorientation score (i.e., a more positive score) represents greater disorientation.

Figure 1. Statistical model for MANOVA design.

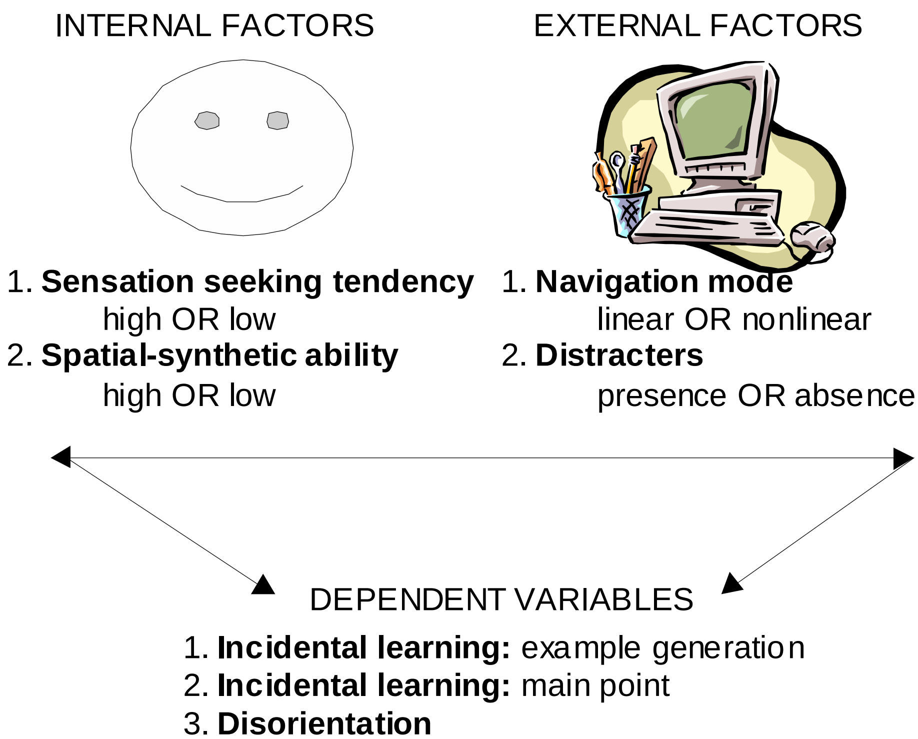


Figure 2. Screen shot of Linear navigation mode with distracters.

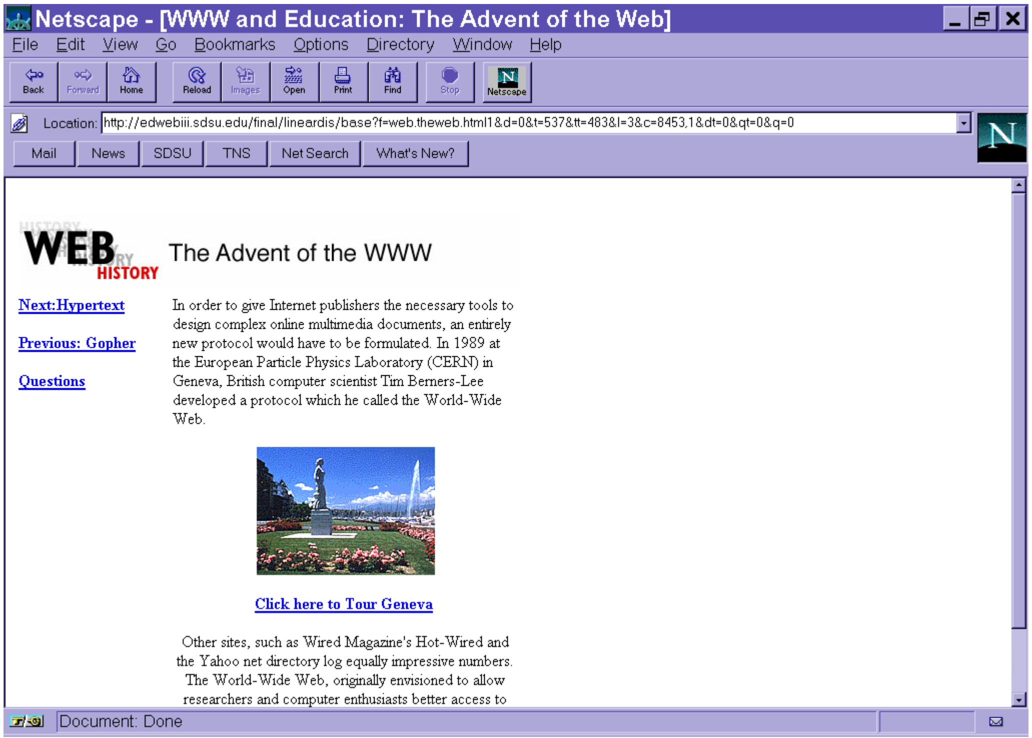


Figure 3. Screen shot of Nonlinear navigation mode with no-distracters.

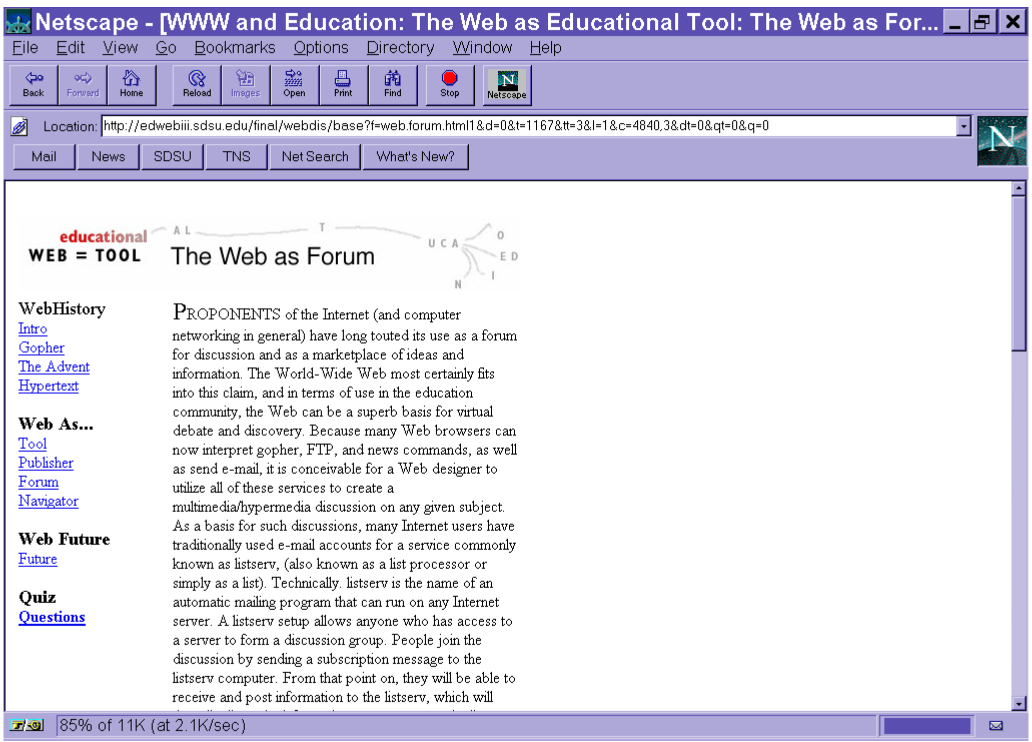
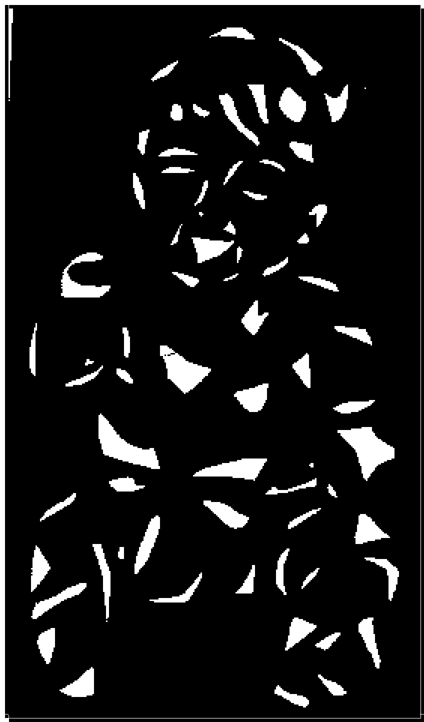


Figure 4. A baby and a bearded man. Two pictures from the 13-item Street Test (Street, 1931).



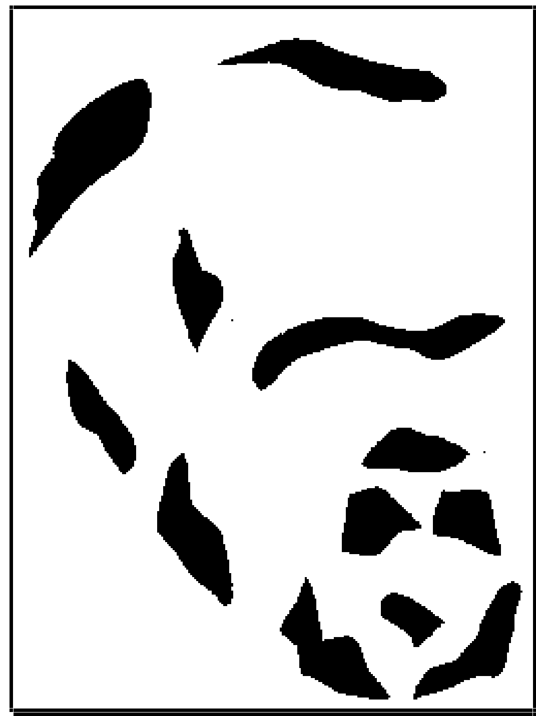
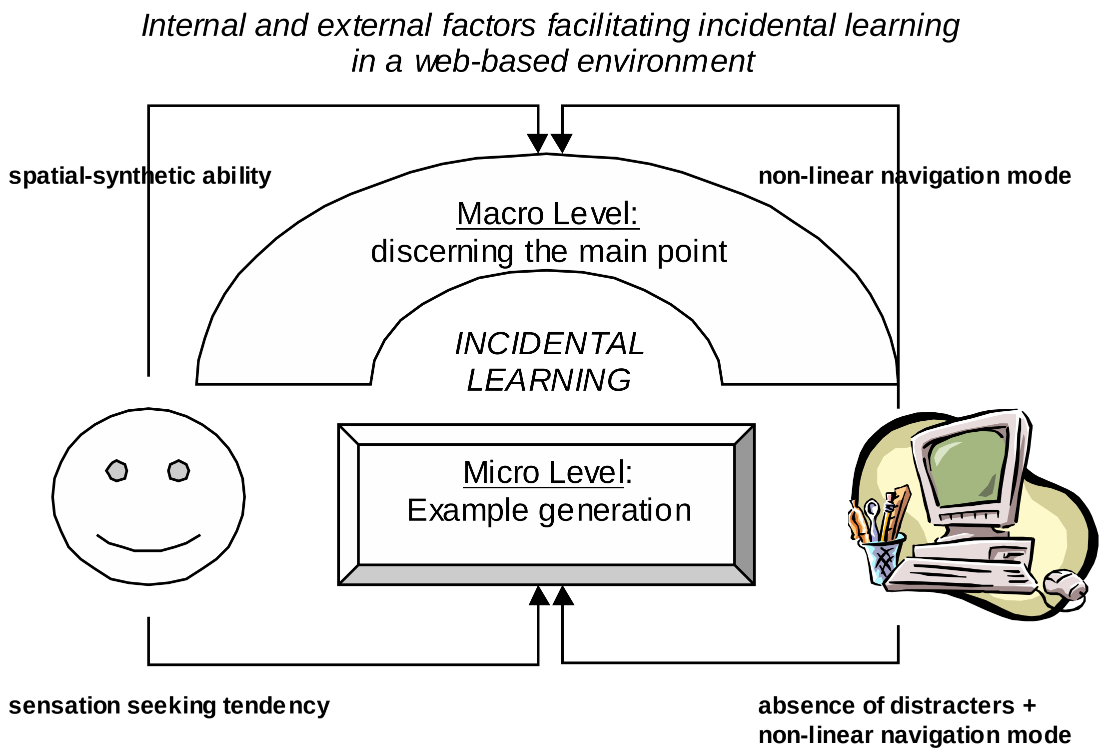


Figure 5. The role of internal and external factors as influencing incidental learning on the Web.



Significant MANOVA Main Effects for Incidental Learning Measures (p< .05)

Source	*df*	*SS*	*MS*	*F*
Accuracy of main point:				
Spatial-synthetic ability	1	5.970	5.970	4.364
Example generation				
Distracters	1	1.857	1.857	3.995
Sensation seeking tendency	1	16.026	16.026	4.901

*Note that while there was not a main effect for navigation mode, there was a moderately-large effect size indicating the positive effect of the nonlinear mode on the accuracy of main point (.35) and example generation (.33).