

Beyond the Printed Page: Style Suggestions for Electronic Texts

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Abstract

When compared to their traditional print-based counterparts, electronic texts often fall far short of the mark in readability, portability, rapid access to information, and the ability to personalize a printed text by highlighting and jotting down notes in the margin. Given these advantages, readers typically exhibit a strong preference for a print-based text instead of its electronic counterpart. The authors propose that these deficiencies derive from an inappropriate model of an electronic text, utilize psychological principles to suggest how to improve electronic texts that are difficult or impossible to reproduce in print media, and describe student reactions to an electronic text, [ePsych](#), that employs these principles. A survey revealed that students in a variety of classes reacted positively to ePsych and rated it better than traditional print-based texts.

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Introduction

Imagine you have the opportunity to visit a newly discovered civilization on Earth. This civilization, whose technology is both primitive and surprisingly sophisticated, has been cut off from the rest of the world for centuries. You visit this strange and different land, learn something of the language, and immerse yourself in this new and fascinating culture. One night you are invited to an entertainment event that has all of the locals excited. You gather, from your limited understanding of the language, that moving images will be shown representing a story. "Ah! A movie!" you think to yourself. "This will be a real treat!"

Your host accompanies you to the building, which indeed resembles a crude movie theater. Then the lights go down and the audience falls quiet. But instead of a familiar movie, words appear projected on the screen with an occasional accompanying sketch. You can barely read the language and so it is difficult to follow the story. Looking around you notice that some members of the audience are quickly

scanning the words, while others read more slowly. As the projection fades out, the audience bursts into applause. "Must have been a good script," you think to yourself. "I wish I could have understood more."

This scenario highlights an important principle: to effectively communicate or instruct requires exploiting the unique capabilities of a specific medium. Using a movie projector to display words on a screen fails to exploit the capabilities of motion pictures to their fullest extent. Hollywood creates realistic movies that employ sound and moving images to create a vivid experience for the audience. The best examples of the film medium (e.g. Hitchcock's *Rear Window*) would lose all of their storytelling power if translated to a textual re-telling of the story.

A screenplay on the silver screen may seem an absurd idea, but many electronic texts are only a small improvement over this solution. Consider a publisher who creates a .pdf file of a textbook and sells it on a CD-ROM. Students may open the .pdf file to read the text and discover that they cannot even read an entire page on their screen; instead, they must scroll down to read the first column, then scroll back upwards to read the second, then scroll past a meaningless page break to view the next page, and so on. A table of contents may be provided, and perhaps the file has some embedded hyperlinks that move the student to a new section of the document without any obvious way to go back. But again, the authors question whether this is a reasonable utilization of such a powerful communication technology.

In study after study, electronic texts fall short of their printed counterparts. Dillon (2004) comprehensively reviewed the literature on electronic versus printed texts, and documented numerous shortcomings of electronic texts. Problems begin with the difference between a computer screen and a piece of paper: paper has higher resolution and can convey more information than a screen can. Books do not have to download and render pages; one can rapidly 'flip through' a book to find material of interest, while computers are slower to access and present material. Books are also highly portable and self-contained: they do not need a network connection or electrical power. Finally, books are personalizable: readers can highlight interesting material, jot notes down in the margins, and so on.

These advantages have traditionally proven unbeatable when printed texts are compared to their electronic counterparts: Users prefer books to electronic texts. For this reason, faculty assign books that cost 4 times what a CD-ROM does, even though students are motivated to cut costs whenever possible.

A central thesis of this report is that the deficiencies of electronic texts are not intrinsic, but are the result of misadapting printed text to a computer environment by not exploiting or exploring the unique capabilities of a computer medium in handling text. Like the screenplay on the silver screen, the approach simply transplants the old medium into the new.

Imagining what electronic texts might be, rather than what they currently are, suggests that a mature electronic text will differ far more radically from its printed text counterpart than a movie differs from a novel. Electronic texts could, of course, include full-screen video: computers can do a fine job of showing the latest DVD. But computers have capabilities that movies lack. A computer can interact with the user as well as simulate a process or model of almost any imaginable sort. In short, an electronic .pdf version of a printed text is no more acceptable than is a screenplay on the silver screen.

Economic considerations also favor electronic texts over printed ones, provided readers will accept them. The economic claim is simple: paper costs more than electrons. Textbooks are expensive and are getting more so: a recent study found that college textbook prices were rising four times faster than the rate of inflation (Rube, 2005). Although this number has been disputed by textbook publishers, there is little doubt that college texts are expensive and getting more so. Sixty percent of a college textbook price goes to publication costs; another 17% pays for bookstore operations, while the author, publisher, and bookstore share the remaining 23% as royalties and profit. As books become lengthier, use higher grades of paper and make more extensive use of 4-color graphics, the production costs will continue to rise. New editions are being released at a faster pace and now average 3.8 years (Pressler, 2004), so books have to be replaced frequently, adding to the price.

It is important to recognize that each new edition of a textbook must be completely republished, no matter

how much (or little) has changed. It is not possible to simply rip out and replace only the pages that require revising – instead the old versions are obsolete and remaining copies are typically destroyed by the publisher when the new edition appears.

Electronic textbooks have a very different set of driving economics. The cost of delivering 4-color graphics is little different from a simple black-and-white text. Reproducing a text can be done on demand by a simple activity like visiting a page on a website. Distribution costs are minimal. Revised editions cost far less to produce than a new edition, as changes can be made incrementally by updating instead of replacing the text. For an existing print-based textbook that costs \$100 nearly all of the \$77 in production and distribution costs could be eliminated in an electronic text that would cost students only \$23 to \$25. These costs could be further reduced by a subscription-based model that did not allow textbooks to be resold to other students, increasing the number of units sold by the publisher.

Style considerations for Electronic Texts

Bradshaw (2005) discussed three factors that help improve student mastery of material: Concreteness, connectedness, and practice. These factors all improve the memorability of text. But other higher-level factors, both internal and external, also have strong influences on learning. Figure 1 presents a partial and incomplete view of some of these factors. Motivation and attention appear at the top of the figure. Motivation might be considered the fuel for learning, while attention is the engine that drives learning. Given sufficient motivation and attention, students will spend time on the task of learning, a crucial factor in any account of human learning (Simon, 2001). However, the benefit of that time depends critically on the specific learning activities and strategies students use. Students may spend their time ineffectively by repeating the material, or they may spend their time more effectively by constructing elaborations, relating the material to familiar ideas, etc.

Motivation comes from extrinsic influences (rewards, punishments, peer-group pressure, parental attitudes) and from intrinsic sources (curiosity, the personal relevance the information may have, etc.). Considerable evidence suggests that extrinsic rewards can undermine intrinsic motivation in educational settings (Deci, Koestner, & Ryan, 1999).

ePsych: an Electronic Text Introducing Psychology

Like the traditional introductory psychology textbook, [ePsych's](#) goal is to introduce students to the field of psychology. However, ePsych incorporates several features to improve student motivation, attention, and memory for the material. Perhaps the most obvious are the inclusion of programs (java applets) that allow students to conduct experiments or to simulate cognitive models and video clip demonstrations. But ePsych also has many other more subtle differences from existing printed texts. First, ePsych does not follow a traditional “textbook” style of presentation: Given the long association students have with traditional textbooks and schoolwork, they are likely to treat any textbook-like coverage as “yet another chore to accomplish.” Instead ePsych uses a journey metaphor in which students visit exotic planets, meet interesting characters, and participate in various adventures. In one module, [Seth Smidlap is captured by aliens](#), and then realizes he is colorblind when he can't tell a ripe red fruit from an unripe-but-poisonous green fruit. In another module, [Professor Mindstein shrinks his class down to microscopic size to inspect neurons and synapses](#). Students respond positively to this style. Students have remarked on multiple occasions “I wanted to look at more material on the site.”

Washburn (2003) noted “game-like conditions promoted efficient and effective training of these undergraduate students, an effect that has been replicated with nonhuman primates, with college students learning classroom-relevant information, and with adults from a temporary employment agency” (p. 190). Our material shares many of the game-like aspects that Washburn identifies: “movement, interactivity, competition, scorekeeping, and graphics” (p. 190). Curiously, similar considerations have discouraged us from incorporating graded quizzes into the site. Although quizzes would allow for scorekeeping, they would also provide an external motivation for performing the task that would likely

undermine the students' internal motivation. Our "skill exercises" are not graded, though they are scored. Their chief purpose is to serve as a tool for practice. Students receive immediate feedback that has been shown to be most effective in promoting learning (Pashler, Cepeda, Wixted, & Rohrer, 2005).

Figure 1 shows that attention is partly a function of motivation, but it can also be influenced by external *environmental attractants*. These attractants are divided into perceptual factors (such as the use of color, movement, and contrast), and cognitive attractants of attention. ePsych incorporates a good deal of color and movement when appropriate. Wender & Muehlboeck (2003) noted that "Research so far indicates that animations are more advantageous for overall retention of the subject matter if the concepts or rules taught contain a temporal course or progression, movement, or spatial relations" (p. 255). Betrancourt and Tversky (2000) concluded "animation is likely to be useful when the learning material entails motion, trajectory, or change over time, so that the animation helps to build a mental model of the dynamics" (p. 326). ePsych incorporates animated graphs ([one illustrates the change in membrane potential over time as a neuron fires](#)), animated videos ([one illustrates an unmyelinated neuron "racing against" a myelinated one](#)), and java applets ([our model of Pandemonium includes real screaming demons!](#)). At a more cognitive level, ePsych's modules often include jokes and employ conventional story elements (plot, challenge to the protagonist, resolution, etc.) that can engage a readers' attention.

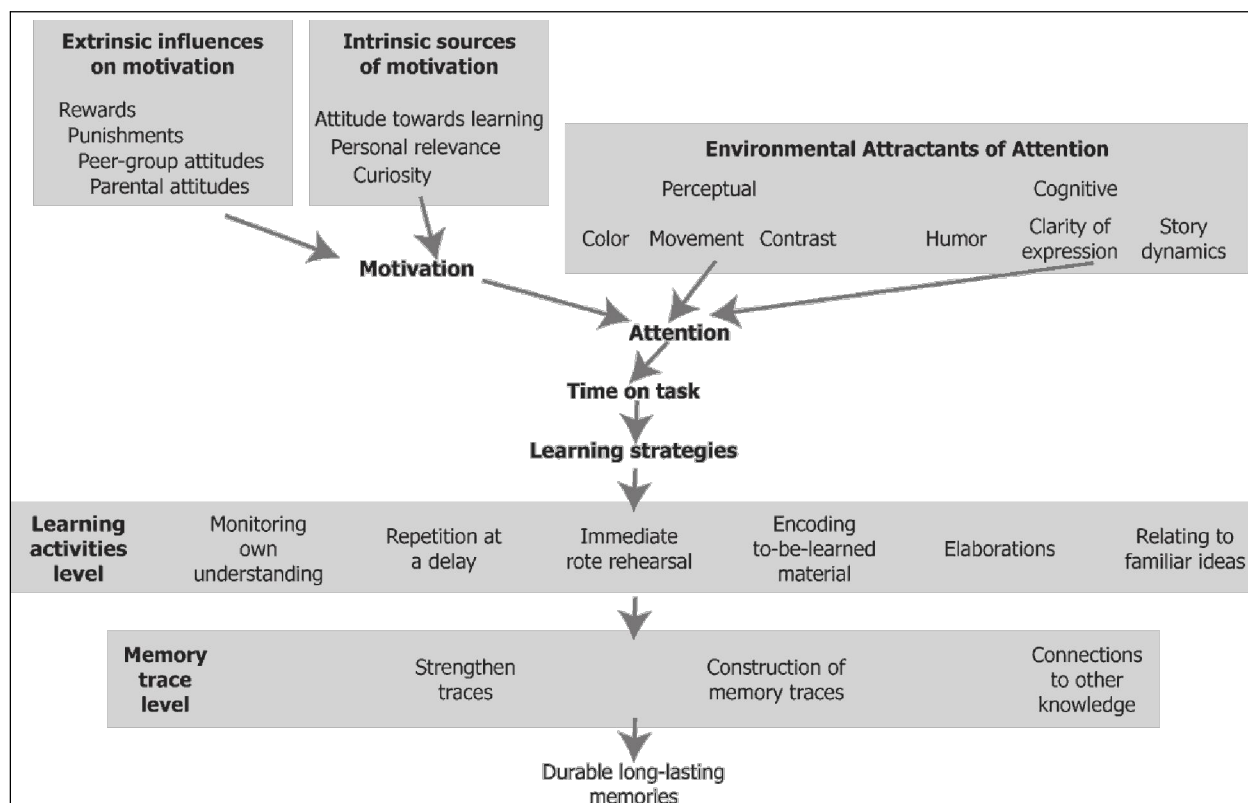


Figure 1. Paths to Knowledge (An Incomplete View)

Another line of research from the education community indicates that material is better understood and remembered if an *embodied agent* instead of an all-but-invisible author communicates it (Moreno, Mayer, & Lester, 2000). This is another reason why ePsych uses characters and story lines in its presentation. Finally, ePsych's principal characters (guides) are young, dedicated, and successful scientists of different races and both sexes who portray scientists in a positive light and can serve as role models for students.

Other Style Considerations: Web versus Text

There are a few other issues that impact student learning, although somewhat indirectly. Many of these issues stem from some significant differences between computer-based publication and traditional textbook publication.

Publishers are concerned with two different costs: the cost of producing the first copy of a textbook and the cost of reproducing that copy. Production costs include payments to authors, editors, artists, and typesetters. The cost of reproduction depends on the length of the book and the number of colors of ink on each page. Introductory Psychology texts incorporate numerous photographs and graphics on most pages. More advanced textbooks use little or no color printing and have a much higher ratio of text to image. Even introductory texts have a fairly high ratio of text to image: It is rare for a textbook to have multiple images to illustrate a topic. This style is dictated by the expense of paper, four-color printers, etc.

In computer-based publication, the economics of reproduction are quite different. A CD-ROM, for example, can hold 600 Mbytes of information as easily as it holds one. This allows authors to shift to a different style of presentation that incorporates considerably more pictorial material. Computer publication via the web has similar economics: The cost of reproduction, especially of color images, is small and inconsequential, permitting a graphically intensive publishing style that is all-but-forbidden in textbook publishing.

Several ePsych modules incorporate this style. One of the best illustrations of this style occurs in ePsych's [module on the neuron](#). This module incorporates several graphs (some of which are animated) to explain the neuron. [Our basic illustration of the neuron](#) itself appears five different times with only two labels per illustration. In contrast, a textbook would present one illustration with 10 labels. Students reading the text need to perform a more difficult search over 10 labels to find the part that is identified, but with ePsych this search is all but avoided. As ePsych's modules have been refined, new ways have been discovered to incorporate a rich blend of textual and pictorial material, interactive models and demonstrations, and key experiments to complete the modules. Adapting material from a book style (books and journal articles are the primary sources of material for the site) to this new computer-publication style is a significant challenge, but one that should ultimately prove to be worth the effort.

Student Reactions to ePsych

In order to determine how successful ePsych is at communicating information to students, a student satisfaction survey was conducted in several courses on different campuses. Students were assigned to read one or more modules on ePsych as a part of their regular class assignments. Then these students were given an evaluation survey that asked several questions about their reaction to the material they read. Several questions asked students to compare ePsych with a traditional printed text. These include items such as: (Q6) "Compared to a textbook, how easy or difficult was it to comprehend the ideas that were presented?"; (Q9) "Which is more convenient and easy to use? A textbook or ePsych?"; and (Q10) "If you had to choose between a traditional textbook and the ePsych module, which do you think you would prefer?" Other questions asked about student reactions to different features of ePsych, including questions like (Q8) "How did you react to the characters who were present in the module?"

Most of the students participating in the survey were from introductory psychology classes (183 students in 4 different classes at three different colleges/universities), but 47 students in 2 advanced classes (Cognitive Psychology and Physiological Psychology) were included as well. Survey questions were based on a 5-point Likert scale, and participation in the survey was voluntary and did not affect student's class grades. (In addition to the 10 Likert-scale questions, the survey included an additional 9 background questions that will not be discussed here.)

A total of 252 surveys were received (students in some classes completed multiple surveys). On all 10 questions the students average responses were positive toward ePsych. Independent t-tests were

conducted on each question to determine whether the average responses differed from the neutral point on the scale, and all 10 questions led to significant results ($p < .001$). The item that was closest to the neutral point (3.0) was Question 10: "If you had to choose between a traditional textbook and the ePsych module, which do you think you would prefer?" The average score for that question was 3.35, slightly favoring ePsych over a textbook. Yet it is significant that this result favors ePsych, while other evaluations of electronic texts usually show a strong preference for a printed text (Dillon, 2004).

Eight items on the survey (excluding Q9 and Q10) were subjected to a factor analysis. The factor analysis resulted in two factors. One factor included only two items, but both measured the interface to ePsych: (Q2) "How fast or slow was it to access the material on the site?"; and (Q7) "How easy or difficult was it to maneuver around the module and access material?" The other factor included questions about how students reacted to characters or the story line, how easy the material was to understand, and so on. The two factor scores were then used in a linear regression to predict the preference for textbook/ePsych on Question 10. Both factors were significant predictors, and the model predicted preferences significantly ($r^2 = 0.328$; $p < 0.001$).

A third regression was performed to predict responses to the question (Q1) "What was your reaction to the ePsych module and the concepts it contained?" Predicting questions included an item about their reaction to the story setting, their reaction to humor in ePsych, and their reaction to the characters in the modules. All three factors were entered in a stepwise regression analysis, with character appreciation being the first item entered, the reaction to humor second, and their appreciation of the story line entered third. The three-variable model predicted enjoyment significantly ($r^2 = 0.258$; $p < 0.001$).

Discussion

An extensive survey, conducted in 6 different classes on four different campuses, demonstrated that ePsych is an effective electronic-text alternative to a traditional printed text. Although 44 surveys indicated a strong preference for a traditional textbook, nearly twice that number, 75, indicated a strong preference for ePsych. The primary reason for preferring a traditional textbook was its universal availability, while the primary reasons for preferring ePsych were its fun style and careful, easy-to-read explanations. ePsych thus demonstrates that it is possible to overcome many of the intrinsic problems with electronic texts by adopting a style of presentation that exploits the strengths of electronic texts: their ability to present multimedia elements, the low cost of including colorful images, and adopting a style of presentation that incorporates story lines and humor to help capture and retain student attention.

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