

## The Future of Research Publishing: The eReport and eJournal

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I am sure that I sound a familiar chord with other research scientists when I express my excitement at the arrival of the latest edition of my favorite research journal. I carefully peel off the wrapper, reach for my favorite color highlighter, reach for my coffee, and sit down in a comfortable chair to digest the latest articles written by fellow scientists. Even the smell of the fresh print and the crispness of the new paper add to the experience. Reading of new discoveries at the cutting edge of knowledge and determining the place of my own research in those advances can be quite exhilarating. But as familiar and as satisfying as these experiences have been—to say nothing of their contribution to the advancement of science—I sense that it is all about to change in a most extraordinary way. The research article and scientific journal are about to meet the Internet, and the world of scientific reporting will never be the same. I will argue that the transition and result will be nothing short of revolutionary.

“Preposterous!” you say. Why would web-based reporting of scientific studies be all that different from traditional paper-based reporting? Researchers will simply submit their articles as HTML or PDF files that can—upon favorable review—be uploaded to the journal publisher’s server. Subscribers will just as simply download files from the server via the Internet. While this might shorten the time from submission to publication, it would not substantively change the structure of the scientific report. So, where is the “revolution?”

The answer is that the transition to online publication of scientific journals is only in its earliest stage. Thus far, online research journals provide reports

that are little more than scrolling text pages. Reed-Elsevier Publications, for example, provides online access to the latest full-text editions of numerous scientific journals. The articles differ in only minor ways from articles printed on paper and—due to relatively poor resolution of type on computer monitors—are undoubtedly less satisfying to some readers. Moreover, the cost of these publications has been disappointingly high, despite the clear savings to the publishers.

Despite these humble beginnings, I would argue that the online publishing of research journals will ultimately transform the way research is reported, disseminated, consumed, and, most importantly, *conducted* by the scientific community. The core of the transformation will be a radical transformation of the structure of the research report and unprecedented changes in the interface and flow of information between researchers and readers. In the past, the researcher assumed an *active* role in the reporting of research, and the reader assumed a *passive* role in the consumption of research. In the web-based eReport, (electronic research report) and the eJournal (electronic research journal) these respective roles will be transformed into *interactive dynamic discourse* between authors and readers.

I will demonstrate these changes by taking you step by step through the traditional sections of the traditional research report: Introduction, Methods, Results, and Discussion. At each step, I will briefly summarize the structure and function of the conventional approach to the section, followed by my prediction of what that section is likely to look like in an eReport in an eJournal. To enhance your experience—and to practice what I preach—I have constructed a website that provides a simulation of an eReport. This content is completely fictitious and is intended only to illustrate the major points of my argument. I suggest that you visit the website at this point and navigate through the sample eReport as you read through the remainder of this article.

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Please open your favorite browser and go to:  
<http://mailer.fsu.edu/~mkrantz/chronicle/mainpage.htm>

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The *Introduction* section of the conventional research report establishes the theoretical and research rationale for the study. Due primarily to space limitations imposed by editors of paper-based journals, the typical *Introduction* presents only a small fraction of the information required by the reader

to fully comprehend and appreciate the scientific basis for a given study. Only the most relevant prior research is cited, and typically in the most superficial manner.

How will this change in the eReport and eJournal? Unfettered by space limitations, the eReport's *Introduction* will include comprehensive development of the rationale of the new study. This is accomplished by the extensive use of embedded *hyperlinks*. Every citation of prior research or theory is linked to layered levels of reference, including the full bibliographical reference, a *brief abstract* of the referenced work, and the *complete text* of each reference cited in the study. Imagine having the entire text of every citation a mouse-click away the next time you read a journal in your field!

Readers at the website will see a table with four hyperlinks embedded in a navigation bar. Each link corresponds to a component of the eReport. Please click on the link labeled Introduction.
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The conventional *Methods* section offers a succinct and parsimonious presentation of the sample, instrumentation, and procedures of the study. Again, constrained by space limitations in paper-based journals, editors force researchers to limit specification of methodological detail. Wherever possible, authors merely cite their sources, placing the burden on the reader to track down the full account of particular methods. Diagrams, charts, and images that would promote understanding and replication are severely restricted.

The *Methods* section is totally transformed in the eReport: With no practical limits on space, the methodology and procedures of the study are presented in unprecedented detail and precision, facilitated by the power of multimedia applications inherent in web-based presentations. But the advantage goes beyond simply providing detail: In the eReport, descriptions of equipment and complex procedures can be linked to static and animated images of the equipment and—if necessary—to streaming videos of the actual implementation of procedures. Imagine reading an e-Report and clicking a button to observe the actual interview of subjects employed by a behavioral scientist, or a vivid demonstration of a medical researcher's new surgical technique; or precautions taken by a nuclear scientist to prevent contamination in a laboratory experiment. Clearly, the use of audio and video to describe

laboratory procedures will elevate the scientific report to previously unattainable levels of objectivity, enabling virtually perfect replication of scientific method from research lab to research lab, an achievement that has been so difficult to achieve in the medium of paper.

Readers at the website will see a table with four hyperlinks embedded in a navigation bar. Each link corresponds to a component of the eReport. Please click on the link labeled Introduction.

The *Results* section of the conventional research report presents the summary of the outcome of statistical analyses. Again, with space at a premium, the researcher is required to minimize the number of analyses, tables, and diagrams. The reader, of course, never actually sees the data and must accept its existence by faith alone. The eReport *Results* section begins with a link directly to the database containing the *actual data* collected in the study. Yes, you read that correctly! The reader will have access to the data for independent review and analysis. Authors will, of course, present their preferred choice of statistical analyses. However, readers will be able to reanalyze the data, including analyses not applied by the researchers. If it appears to the reader that the author has violated statistical assumptions, s/he may reanalyze the data by alternative methods to see if the results might be different. I believe that providing access to the actual database in the eReport represents a significant advance toward the achievement of objectivity of scientific reporting.

At the website, click on the *Results* link on the navigation bar, and then click on the buttons embedded in the page. You can access the database by clicking a button, and reanalyze the data by clicking another button.

And finally, we consider the so-called *Discussion*. I say “so-called” because, by definition, discussion involves the *exchange* of opinion and fact by at least two or more individuals. The *Discussion* section in the conventional report provides summary, interpretation, integration, implications, and conclusions only from the perspective of the researcher. There is no mechanism—and some might argue no intent—to generate “discussion.”

At the website, readers should click on the *Discussion* button on the navigation bar and then click on the embedded links.

This changes dramatically in the eReport. As in the conventional paper-based report, the researcher presents his/her interpretation, integration, and implications. In the eReport, the researcher prepares these components as a dynamic body of information specifically designed to elicit the reactions, opinions, criticisms, and recommendations of the readers. After reading the author's views, readers may respond to the author's interpretation and conclusions by clicking to a threaded discussion (synchronous and asynchronous chat). The online discussion encourages continuing commentary and critique among interested readers, thus promoting collaborative research.

Before I conclude, I would like to mention one additional advantage inherent in the eJournal. How often have you received the latest edition of your favorite journal only to find just one or two articles of interest? What a waste of paper and space on your bookshelf! While conventional journals deliver a finite number of articles, the eJournal publisher would be able to offer the subscriber a menu of new articles for selective downloading. Online music companies have provided a useful model by allowing consumers to download "singles" rather than entire albums. The eJournal subscriber would download—and pay for—only those articles of interest.

I argue that the changes I have described are revolutionary; the eReport will change not only the way we *read* research, but also the very way we *conduct* research. The unprecedented access to and exchange of information and data will level the intellectual playing field between established and neophyte researchers. Threaded discussions will stimulate and facilitate collaborative research, sharing of databases, and creative thought in ways that no one could possibly achieve just a few years ago. Put simply, the free movement of electronically published research and commentary from desktop to desktop throughout the world will revolutionize the way we do science.

And I offer a few final comments to the skeptics. If you think that slow downloads are a major problem for online journal publishing, be aware that bandwidth is about to explode with the implementation of Digital Subscriber Line (DSL), cable, and wireless technologies. Broadband will be to electronic

publishing what the printing press was to the publication of books. If you believe that poor resolution of electronic print will dissuade readers, be aware that vastly improved screens and ClearType technology (Microsoft Corporation) will create screen print roughly equal to the quality of print on paper page.

Will the journal publishing companies resist these changes? The answer is yes, at least in the short run. But the publishing industry is built on a fragile foundation of paper. The pressure will come from the bottom line. Web-publishing is so inexpensive and easy to implement that just about anyone armed with a good web-authoring tool (such as Microsoft's *Frontpage* or Macromedia's *Dreamweaver*), a few megabytes of rented server space, and the appropriate scholarship can publish and disseminate a scientific journal. I expect that some enterprising software company (perhaps after reading this article) will soon introduce eREPORT-SOFT, the "killer app" for scientists who must publish or perish in cyberspace. Publishing companies and professional organizations that resist the changes will be left behind, buried under stacks of useless paper.

Will I miss the opportunity to curl up with my favorite paper-based journal? Perhaps...but I believe that this is a small price to pay for the extraordinary improvements in scientific reporting, communication, and collaboration that will inevitably come with the emergence of the eReport and eJournal as the new standard for scientific publication.