

Encouraging good science on the Web

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Science is a popular topic on the Web. General reference sites like Wikipedia have large archives of science reference material. Elementary through high-school students these days do their research primarily on the Web, not with books. The general public and citizen scientists avidly absorb and contribute science-based website content. However, not all the science content is being written by scientists, particularly on open sites that allow any user to post information. Yet sites that allow only scientists to contribute often suffer a dearth of content, which causes viewers to drift to larger but less authoritative sites. A good way to better ensure scientific accuracy on the Web is to encourage scientists to contribute.

To secure active participation and content generation by scientists, academic and research employers must acknowledge the value of expert contributions to Web knowledge bases in such a manner that scientists are encouraged to contribute as an appropriate part of their job. A direct way to achieve that end is through the use of citations very similar to those in journals.

Expert sites include wikis—Web encyclopedias like Wikipedia (<http://www.wikipedia.org>) and the Encyclopedia of the Cosmos (<http://www.eofcosmos.org>) that allow anyone to edit their content—and topical communities such as Modeling Guru (<https://modelingguru.nasa.gov>), a NASA site for sharing scientific modeling codes and discussing methods. They also include niche sites such as NRC-RAP (<http://www.nrc-rap.org>), which hosts the information-sharing forums and frequently asked questions specifically for postdoctoral fellows of the National Research Council's Research Associateship Programs.

Inquiring readers can find on those sites an archive of information and solutions—for example, software codes, methods, answers to common problems, and links to other resources. Often the websites have forums for discussion or for finding quick answers to topical questions. They can also serve as online meeting places where remote

users can share data, results, and ideas. Such sites are intrinsically collaborative in that readers can also write and post material.

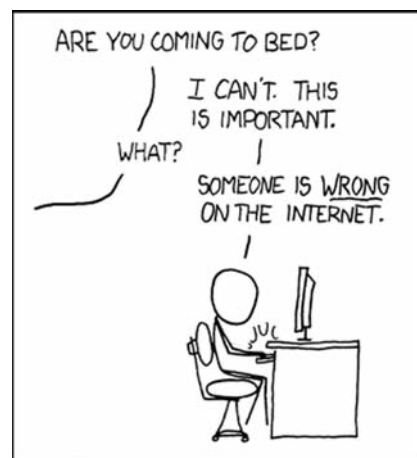
In some cases, a website may be substantial in the amount of content it carries but nonauthoritative with regard to the scientific quality of that content; Wikipedia falls into that category because anyone, even anonymous posters, can edit its content. Moderated or invitation-only sites often exercise more conventional editorial control to improve the quality of contributions. The levels of editorial oversight strategies for websites do not differ greatly from the existing tiers of scientific journals. As with individual papers in refereed journals, websites do not all need to be of equal value.

Participation: The first hurdle

In the scientific community, it is crucial to secure the contribution and participation of experts. For science-oriented websites, expert contribution increases the accuracy and overall value of the content. For websites that provide models, software, or other resources and for those that encourage collaboration, contributions from higher levels of expertise increase the utility of a site.

Such expert contributions, in turn, allow a wider base of users to perform their science at a higher level by using the resources contributed by others. As a side bonus, a larger and more sophisticated pool of contributors leads to better Web tools for making contributions: Web developers tend to improve the tools for their more active and productive users. The improved tools, in turn, make it easier to add value to the content and make community engagement more enjoyable. Weblogs, for example, were created when online columnists requested forum tools for reader feedback, which, in turn, allowed authors to have a dialog with readers.

However, populating and sustaining a website requires a sufficiently large pool of motivated expert contributors. Not only is the pool of potential experts in science smaller than for, say, topics in pop culture, but a typical sci-



entific expert is usually short on time.

Given that a scientist has a finite amount of time to write, he or she can choose to write a proposal to obtain funding, a paper for publication and subsequent listing on a curriculum vitae (CV), or an item to be posted to the Web. Subject-matter experts can be encouraged to participate and contribute online by highlighting the rewards that their time, effort, and expertise can generate. Four primary rewards motivate a career scientist to contribute:

► **Altruism.** Some science experts will participate simply because educating and enlightening people brings them satisfaction. They believe outreach and dissemination are as important as curiosity and discovery. Some scientists may so dislike inaccuracies and mis-truths that they instinctively correct erroneous information they encounter, in order to reflect current scientific understanding.

► **Acclaim.** Scientists participate to be lauded as experts in a given microcommunity or on a specific topic of interest. Gaining the respect of the community that revolves around a given website provides experts with a sense of satisfaction and posted kudos, but little else.

► **Reputation.** If Web contribution enhances scientists' overall reputation in their professional community, they will contribute. This is separate from any ego-boosting acclaim they may get by contributing. For example, a poorly received talk at an American Geophysical

Union meeting currently carries more resumé cachet than a vigorous online forum debate on the same topic.

► **Remuneration.** Scientists, like many other people, will contribute to online forums if it increases their earning potential. This can be direct payment (salary or per piece), or by virtue of an enhanced resumé if Web contributions can lead to better career advancement.

Because altruism and acclaim are personal drives that motivate only some individuals, our already small pool of potential scientific experts is reduced by those not so motivated. Existing internet reputation mechanisms such as ad hoc titles—for example, editor, forum lead, blogger, moderator, or expert—do not yet have standing beyond the website that offers them, because such titles do not have standard definitions or authority that is recognized in the professional marketplace. Authorship in refereed journals and committee work for professional societies and conferences are already recognized, but similar standards for internet-community contribution and engagement do not yet exist.

Conferring career value

It is important that the scientific community find a way to give Web contri-

butions a career value that is equivalent to those other community interactions. Making frequent authoritative Web contributions count is ultimately a cultural decision. Participants in the scientific culture—leaders, committee members, funding boards, and research participants alike—need to value the efforts of scientific experts who engage with their peers and the community at large to improve scientific understanding. And citable authorship tends to have a dampening effect on the plagiarism that all too frequently occurs on the internet. Perpetrators are easier to catch if sources are properly credited, and that fact may further encourage contributions.

Jonathan Zimmerman, a professor of history and education at New York University, wrote some thought-provoking comments for the 9 March 2009 online *Christian Science Monitor*. In an Opinion piece titled “Professors Could Rescue Newspapers” (<http://www.csmonitor.com/2009/0309/p09s01-coop.html>), he issued a call to action and suggested that professors from all disciplines should write for free. He pointed out the problem:

So what would be in it for them?
Right now, nothing. . . . But we can change that, too.

Suppose that 30 to 40 prominent research universities issued a joint statement, urging their faculty to publish in popular venues—and promising to consider such articles in promotion and salary decisions. Believe me, you’d see more and more professors writing for the newspaper.

One primary mechanism to motivate experts to contribute is to encourage formal citation of Web contributions. Formal citation lets contributors improve their reputation in a quantifiable way, by adding line items to a quarterly performance evaluation or CV. Such tangible boosts to reputation can then increase remuneration along the contributor’s career path.

A standard Web citation could include the name of the contributor, the type of contribution (author, editor, reviser), the webpage name, site name, the date the contribution was posted, and the URL. The following is an example:

A. Antunes and K. Mukai, authors, “Bats on the Shuttle,” *Imagine the Universe: Ask an Astrophysicist*, 24 October 1997, http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/971024a.html

Citations are the primary currency of the research world. An author-researcher must appropriately cite the work of others; and the number of times one’s work is cited is a measure of that person’s scientific influence. Encouraging the citation of expert contributions to the Web creates a cultural acceptance that such contributions are also viable line items for employee evaluation reports and review boards; that acceptance provides economic incentive by legitimately enhancing the contributor’s CV. Community-accepted citation encourages employers to buy into the idea that expert websites are valuable to their overall mission objectives. Recognized citations for Web contribution on a CV or report will enable scientists to shift from hobby or as-needed contributors to the more robust role of fully engaged and participatory experts.

For a citation standard to be considered useful, it must be recognized by the academic and research workplace communities. A national professional scientific organization, a national laboratory like Los Alamos, or a government agency like NASA can jump-start expert contribution efforts by adopting and promoting a citation standard for Web contributors to receive appropriate credit for their work in community engagement and peer collaboration. ■

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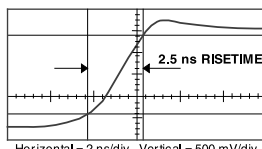
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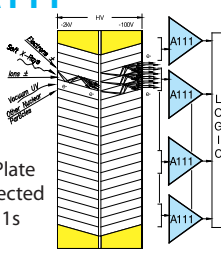


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