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2006-10-01

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Wiley, David, "Open Source, Openness, and Higher Education" (2006). *Faculty Publications*. 289.
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Open Source, Openness, and Higher Education

by David Wiley

With the growth of open source software and other related trends, a culture of openness is advancing from the edges of society to the core of academic culture. In this article I provide an overview of how the expansion of open source software in culture at large has affected the world of education, describe how the greater use of open source software in education has unfolded hand-in-hand with the development of open course content and open access research, and argue that this more comprehensive shift towards "openness" in academic practice is not only a positive trend, but a necessary one in order to ensure transparency, collaboration, and continued innovation in the academy.

From the Margins to the Mainstream: A Recent History of Open Source Software

There once was a time when open source software was the sole province of the geek and existed behind barricades impassable by ordinary computer users. The first major barrier was inscrutable jargon; users who did not understand the meaning of commands such as `./configure; make; sudo make install` were often simply left out. A second obstacle was that most open source programs, such as Web servers and mail servers, were limited primarily to applications and utilities that were useful to servers and network administrators; such resources went beyond the needs of the average desktop computer user. Even those applications that might have broader appeal, such as text editors, were often so complex that running them seemed to require a specialized degree. A further limitation was that most open source software was written exclusively for free, Unix-like operating systems. Finally, these tendencies, in turn, contributed to another major barrier—namely, the common perception among average computer users that free applications must surely lack the intuitive features and accompanying technical support of commercial applications. In short, the world of open source was closed off to normal people.

Recent developments, however, are bringing open source into the lives of average desktop computer users. In addition to their availability for open source operating systems like Linux, many open source applications are also available for proprietary operating systems like Windows and Mac OS X. Installing these applications generally works like installing commercial software—users just double-click to begin the install process. In many ways, recent trends in the open source world can be seen as a distributed effort to replace popular proprietary software with easy-to-install-and-use open source software. Options for nearly all commonly used programs abound. For example, in place of Microsoft Office, users can run [Open Office](#), an MS Office-compatible open source replacement. One alternative to Microsoft's Internet Explorer is [Firefox](#), an open source Web browser with all the features of its commercial counterpart. Instead of Microsoft Outlook, users can try [Thunderbird](#), a full-featured, open source e-mail application. [Jabber](#) not only offers an open source alternative to AOL's Instant Messenger but also allows users to chat with people running software from AOL, MSN, Yahoo!, and ICQ. Word processing, working with spreadsheets, crafting presentations, surfing the Web, managing e-mail, and chatting with co-workers and friends probably account for the vast majority of the time average desktop computer users spend at their machines. While these users and their needs for simple installs and familiar interfaces were all but ignored only a few years ago, today it is actually possible for anyone to perform the basic tasks outlined above without ever launching a proprietary application. Even more specialized needs can be satisfied with alternative sources of software for users who look for them. For example, one can visit Google, enter "open source photoshop" or "open source mathematica," and discover programs such as [GIMP](#) and [Maxima](#), respectively, or a host of other versions of completely free and open source software.

Open source software enters mainstream use when it compares favorably to proprietary applications in terms

of available features and technical support. In some cases, freely available software surpasses commercial rivals in these critical areas and thus compels the industry to improve its products. To cite just two examples, [Firefox](#) users for years have taken for granted certain features such as tabbed browsing that are only now being adopted into a beta version of Internet Explorer, and users of [Apache](#) have enjoyed excellent e-mail and chat support. In these ways the open source movement has helped raise standards within the market at large and has served as a catalyst for productive innovations that many people now regard as essential to software functionality and design.

The Empowering Nature of Open Source Software

In today's economy, the ability to provide services or create products that people value is generally impossible without computing and software capabilities. When the cost to purchase or license software is prohibitively expensive, all but the very wealthy are prevented from innovating in the areas of new products and services. Much like the exploited workers of Marx's writings, who cannot afford expensive machinery and so must eternally rent their labor to someone else already rich enough to afford factory machines, normal computer users find themselves unable to afford the high price of much proprietary software, and this prolongs the situation in which workers cannot afford to own the means of production or direct their own labor.

Such a rigidly hierarchical set of relations has now begun to change. Open source software empowers users by making a critical part of the means of production—software—freely available, allowing ordinary people to direct their efforts as they please. The recent history of the Internet is, in fact, the history of tens of thousands of people empowered to bring a variety of innovative services and products to market because the tools for creating them were within their financial reach. It is a history of average users armed with open source software competing successfully with multinational corporations armed with expensive, proprietary software.

The impact has been substantial. In an April 2006 [Netcraft](#) survey ([2006](#)) of 81,565,877 Web sites, over 64% of all sites surveyed were running the open source Web server [Apache](#) as compared to 25% running Microsoft's IIS Web server. After Web server software, arguably the next most important class of software for creating products and providing services include those tools that are used to write Web-based programs. Open source languages like [PHP](#), [Python](#), [Perl](#), and [Ruby](#) proliferate in this area as do open source application development environments like [Ruby on Rails](#), [Zope](#), and [PEAR](#). (Users not familiar with any of these languages or frameworks can access [try Ruby](#) from within any browser without installing anything. Anyone can also watch some [screencasts](#) of what it is like to develop in Ruby on Rails—I particularly enjoy one application that goes from nothing to a functioning blog in only 15 minutes and 58 lines of code.) This open source, critical infrastructure continues to serve as the fuel driving innovation in practically every sector of the economy.

In addition to using open source software to build Web applications, average users are making increasing use of open source applications for everyday online activities like instant messaging ([GAIM](#)), journaling or blogging ([WordPress](#)), and sharing pictures with family and friends ([Gallery](#)). In this regard the impact of the open source movement has clearly moved beyond the more specialized spheres of software development and Web site management, allowing users at all levels to gain greater access to technological means of production outside the exclusive domain of proprietary software.

Moving into Education

In turn, the growth of open source software in the public at large has begun to make itself felt in various ways within the arena of education. This influence can be seen most directly in the wide array of open source software applications now available to educational institutions and instructors. At the same time, this influence can also be seen in the further steps towards openness that have begun to take place outside the specific context of software use—in particular, the dissemination of open access course materials as well as the creation of open access research repositories and electronic publishing venues.

Software

Educational institutions have a growing array of options to consider when acquiring software. Learning and course management systems (CMS) like WebCT and Blackboard can now be replaced by attractive open source alternatives like [Sakai](#) and [Moodle](#). In recognition of these options, Athabasca University ([2006](#)) has recently announced their adoption of Moodle as their official CMS, and other institutions such as the British Open University ([2005](#)) have taken this step as well. Meanwhile, a plethora of educational applications are available to support student learning in both higher education and K-12 contexts. Open source applications that teach and tutor on every subject are surprisingly abundant—one need only search a site such as [SchoolForge](#) to survey the range of options.

Moreover, the potential for the development of education-specific features within existing open source software promises additional opportunities. Open source applications are, by design, adaptable and can therefore be applied to a variety of uses. For example, photo gallery software designed for sharing and rating photos could be adapted for sharing and rating essays, CAD files, or musical compositions. Software designed for creating interactive multimedia presentations could be adapted for a course module illustrating the phases of bacterial cell growth or the relationship between supply and demand in classical economic theory. If the redesign of non-educational software for educational use has always been possible in principle, the highly flexible design of open source applications provides the ideal way to put this principle into practice.

Teaching

The open source philosophy is having a much broader impact in education than just changing the way universities license software—it is also changing the way faculty disseminate research results and teaching materials. A recent report (Wiley [2006](#)) produced for the Organisation for Economic Co-operation and Development ([OECD](#)) makes plain the extent to which educational institutions are adopting the open source mindset in their use of educational resources. Approximately 175 universities worldwide currently participate in programs through which they provide free and open access to the content of over 2,000 university courses; [MIT OpenCourseWare](#) provides the majority of these courses, but with efforts underway at universities in Australia, Brazil, Canada, Hungary, India, Iran, Ireland, the Netherlands, Portugal, Russia, South Africa, Spain, Thailand, the UK, the US, and Vietnam, that majority position is not likely to last long. The move to share the content of university courses openly is growing at an amazing rate.

Many other kinds of educational resources are widely shared, thanks to the open content philosophy. Thousands of smaller educational modules are accessible through collaborative online projects such as [Connexions](#). The Web site [Textbook Revolution](#) indexes and provides free access to over 150 textbooks made available by their authors and copyright holders. In the spirit of reusing and adapting shared material, many of these resources are being translated into Spanish, Chinese, Portuguese, and other languages. Meanwhile, the Multimedia Educational Resource for Learning and Online Teaching ([MERLOT](#)) currently offers access to almost 15,000 educational materials.

Research

For years now an undercurrent of dissatisfaction with traditional publishers of scholarly research has been swelling in academia. The expression of frustration goes something like this: Researchers work hard to develop new research ideas, to attract funding to support the new research, to carry out the research itself, and to describe the results in order to communicate with others, and in exchange for publishing the work produced in universities, journals demand that authors sign over all copyrights to their own research. This leaves researchers in the unfortunate circumstance of not owning the descriptions of the results of their own work. When researchers want to use their own descriptions of their research, they must acquire the agreement of—and sometimes even provide payment to—the journal that owns the copyright to the researcher's work product. The question is repeatedly raised: How did this situation arise, and what can be done about it?

Faculty seeking alternatives should consider projects such as arXiv.org. According to the Web site, arXiv is "an e-print service in the fields of physics, mathematics, non-linear science, computer science, and quantitative biology" that provides open access to over 367,900 academic papers as of May 2006 (arXiv e-Print archive, [n.d.](#)). While papers in the archive are not necessarily peer-reviewed, the collection is generally of excellent quality.

Another response to the power of publishers is an initiative called the Public Library of Science ([PLoS](#)), which is peer-reviewed. The PLoS Web site recounts the history of its founding:

Following its founding in October 2000 by biomedical scientists [Harold E. Varmus](#), [Patrick O. Brown](#), and [Michael B. Eisen](#), PLoS's first action was to circulate an [open letter](#) encouraging scientific publishers to make the research literature available for distribution through free online public archives such as the US National Library of Medicine's PubMed Central. This letter, signed by nearly 34,000 scientists from 180 countries, prompted significant steps by many scientific publishers towards freer access to published research. Unfortunately, the publishers' responses fell far short of the reasonable policies we advocated.

In 2003, PLoS launched a nonprofit scientific and medical publishing venture that provides scientists and physicians with high-quality, high-profile journals in which to publish their most important work. Under the open access model, PLoS journals are immediately available online, with no charges for access and no restrictions on subsequent redistribution or use, as long as the author(s) and source are cited, as specified by the [Creative Commons Attribution License](#). ([n.d.](#), "What We Do," ¶ 1-2)

Importantly, because journal impact factors depend heavily on how many times articles from a given journal are cited, open access journals have a huge advantage over traditional restricted-access journals. *PLoS Biology* has been in existence only since 2003; yet when Thomson ISI calculated the journal's very first impact factor in 2005, it was [13.9](#), making *PLoS Biology* the most-often cited journal in general biology, ahead of more established outlets like *Proceedings of the National Academy of Sciences*. I am unaware of another research journal that has, so to speak, debuted at number one. In a recent article in *PLoS Biology*, Eysenbach ([2006](#)) describes the benefits of OA (open access) publication:

In a logistic regression model, controlling for potential confounders, OA articles compared to non-OA articles remained twice as likely to be cited (odds ratio = 2.1 [1.5-2.9]) in the first four to ten months after publication (April 2005), with the odds ratio increasing to 2.9 (1.5-5.5) ten to sixteen months after publication (October 2005). (¶ 1)

Eysenbach modestly concludes that "OA is likely to benefit science by accelerating dissemination and uptake of research findings" (¶ 1). Yet as a model for how open access journals can overcome the constraints that researchers face in the field of academic publishing, *PLoS Biology* clearly has broader implications outside the specific field of science. As other disciplines recognize the value of peer-reviewed e-journals for their own research, the precedent set by *PLoS Biology* will help stimulate similar efforts to make open access the norm rather than the exception for academic publication.

Does Open Access Threaten Faculty Jobs?

There are some who might worry that open access to teaching materials threatens the livelihood of teachers. Some faculty members may wonder, "If people can watch videos of my lectures online or read my lecture notes, then why would the university keep me around at all?" This is a sensible concern, but as the history of libraries demonstrates, the vast majority of instructors have nothing to fear.

During the late 19th and early 20th century, Andrew Carnegie founded or endowed libraries all over the world—more than 2,500 of them. These libraries provided open access to collections of educational materials. Undoubtedly, most universities in the world today have libraries filled with collections of openly accessible educational materials. Why do faculty not feel threatened by university libraries? The logic should be exactly the same. Why do they not ask, "If students can read the lecture notes or textbooks of the very best minds in the world on each subject in the university library, then why does the university keep me around at all?"

The answer is, of course, that true teaching encompasses much more than the mere transmission of information. For most faculty, open educational resource initiatives are no more of a threat than the university library. Only instructors who provide no more interactivity to their students than would a book borrowed from the library need to fear greater access to information. Personally, I have always believed that any professor who could be replaced by a collection of educational materials deserves to be replaced by them.

The Future of Openness in Education

One of the key mechanisms underlying the success of the open source approach has always been at the core of higher education's workings and values—peer review. Most academics are familiar and comfortable with blind peer review of their research. Nonblind review of the teaching practices and materials of instructors, as would be typical of open source protocol, is likely to be another matter. As uncomfortable a proposition as this new openness may be for some, I believe it is the future of higher education.

As I recently testified to the Secretary of Education's [Commission on the Future of Higher Education](#):

Many in the public look up to Research I universities as the very pinnacle of higher education. It may be surprising, then, to hear that when faculty at MIT, USU, and other universities are invited to open their syllabi, lecture notes, assignments, and other materials for everyone to see, some faculty respond by asking first for time to tidy up their course materials. They are cautious because the move toward openness takes teaching directly into the heart of the scholarly world for the first time—it exposes teaching to the quality-increasing pressures of peer review. This openness also opens the materials to other kinds of review, creating an unprecedented level of transparency to all higher education stakeholders, including parents and alumni, with regard to an institution's teaching and learning activities. (Wiley [2006](#), 5)

Just as the principle of diversity and its attendant benefits have been the focus of a decade or more of concentrated advocacy within higher education, we must begin making a conscious effort to promote a culture of openness in all aspects of academic life—in our teaching, in the results of our research, and in the software and other tools we use to perform our work. Students, faculty, and staff around the world are awakening to the power of openness to transform higher education.

The world is changing in many ways as popularized by recent books such as *The World Is Flat* (Friedman 2005). Business, science, and other areas of society already leverage these changes to their benefit. In contrast, higher education has adapted too little in response to these changes and is consequently in very real danger of becoming irrelevant. Higher education's willingness and ability to evolve toward openness will be a strong predictor of its future relevance. If higher education is to fulfill its mission as set forth in visionary documents like the First Morrill Act ([1862](#)), which granted land to the states for colleges that would "promote the liberal and practical education of the industrial classes on the several pursuits and professions in life" (Section 4[8]), openness must become a core part of academic culture.

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