Special Book Article

Electronic publishing: Past, present, and future

It's been three and a half years since BioScience last examined some of the issues surrounding the emerging role of electronic technology in biology publishing and education (45: 626–630)—an eternity in the world of computer technology. Since then, the field of electronic publishing has matured. At the same time, the use of computer technology in biology teaching has been changing rapidly. Yet the field is still in its infancy, and the role of multimedia "is still a front-burner question with a lot of people, especially publishers," says Andrew Sinauer, president and editor of Sinauer Associates and a partner in a new multimedia publishing venture, The Mona Group.

In October of 1995, when the previous article appeared, many college textbook publishers were just beginning to develop their first CD-ROM products and there was still a dearth of computers with CD-ROM drives. Other 1995 trends in electronic publishing included a shortage of high-quality CD-ROMs and other electronic material for teaching biology at the college level, a belief by many that CD-ROMs were a transitional technology that would eventually be replaced by online access, and a view on the part of textbook publishers that marketing CD-ROMs was a financially risky proposition.

Electronic publishing has broadened considerably since 1995. Today, most textbook publishers have numerous educational biology CD-ROMs in their catalogues and at least some biology-related material on their Web sites, although most are still grappling with how to make a profit from multimedia CD-ROM and online instructional materials. And companies that focus exclusively on developing multimedia CD-ROMs or Web-based material for use in biology education have increasingly come into the picture. In addition, more professors and universities are developing their own multimedia teaching tools for biology and are turning to the Web as a means to provide course materials to their students.

Although multimedia materials, which generally include graphics, animations, simulations, sound, and video clips, continue to be delivered most often via CD-ROMs, the increasing pervasiveness of the Web is having a major impact. More teaching and learning materials are being made available online—by instructors as well as by companies. These materials range from lecture notes and outlines, to links to other relevant Web sites, to multimedia visuals and interactive exercises and simulations.

Using electronic technology to teach biology

Electronic technology, including CD-ROMs and the Web, is being used by biology teachers and students in many different ways. Instructors are increasingly using multimedia presentation software in their lectures. They are also using multimedia in "dry lab" situations, in which computer simulations enable students to conduct experiments that they could not do in the traditional "wet lab" or in the field—including some experiments that would take months or years to complete in real time. For example, when biologist Mark Decker was at Kansas State University, he created a computer simulation that shows the changes in allele frequencies in a population of red and green beetles over many generations in response to natural selection, with the student playing the role of predator. Students are also using CD-ROMs and online content on their own—to learn new concepts or review material that was covered in class; to obtain lecture notes and review images from the lectures; and as a substitute for traditional lectures, both on campus and in distance education.

Both developers of multimedia products and biologists who use multimedia in their teaching say that animations and simulations offer advantages for students and teachers. "There's both an entertainment side, in that you can enliven a lecture by using [multimedia] visual aids, and there's the ability to clarify difficult concepts," says Linda Chaput, president of Cogito Learning Media, a multimedia publishing company based in San Francisco. James Gould, a biologist at Princeton University, uses digital technology—including still images, animations, simulations, and QuickTime movies—in his introductory biology, animal behavior, and statistics courses. Based on feedback from his students, Gould says, he is "more or less sold on [multimedia] as a way of presenting things with more interest."

In addition to helping engage students' interest in lectures, multimedia can help students understand biological processes ranging from transcription and cell division to population dynamics and evolution; it can also help them grasp difficult concepts, such as the chirality of amino acid molecules or the structure of DNA, in a way that mere words or the static, two-dimensional images in textbooks and on slides and overhead transparencies cannot, say proponents of this technology. Decker, who now develops multimedia software for teaching introductory college biology at the University of Minnesota, says that among the dozens of faculty members who have

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March 1999
used the multimedia presentation software at Minnesota over the past 10 years, "every single faculty member has said that this is something that improves their teaching, that they're able to get points across to students that otherwise they wouldn't be able to do."

Digital presentations also offer the advantage of being relatively easy to change and update, thanks to presentation software packages. Presentation software such as that developed by Rick Peifer and Kyle Hammond, at the University of Minnesota, lets instructors assemble their own customized multimedia presentations from material on a CD-ROM or from other digital sources, such as videodiscs. (The software is available for free on the Web at www.biomedia.umn.edu.) Gould, who together with his son Grant F. Gould developed a presentation program that is distributed on a CD-ROM by W.W. Norton along with the sixth edition of his introductory biology textbook (Biological Sciences, by James L. Gould and William T. Keeton), notes that with such presentation software, if you come across new material relevant to a course, "within a few minutes it could be in your lecture."

Material published on the Web, too, can be easily changed and updated, notes Jim Behnke, vice president and director of new media for Addison Wesley Longman. "If somebody clones a sheep, that's not going to be in any of the books for a long time, but it can be up on our Web site the next week," he says. Behnke is one of the founders of Peregrine Publishing (now a subsidiary of Addison Wesley Longman), which produces a series of commercial educational Web sites, including The Biology Place and The Chemistry Place.

The rising tide of computer technology on campus

Reflecting the impact that computers and the Web are having on higher education, results of the 1998 Campus Computing Survey—an annual survey of officials at two- and four-year US colleges and universities—show that the use of technology in college courses is on the rise. The survey found that, in 1998, 44 percent of classes were using e-mail, 33 percent were tapping into Internet resources as part of their syllabus, and 22 percent were using Web pages for class materials and resources. In 1996, by contrast, these figures were just 25 percent, 15 percent, and 8 percent, respectively.

The rise of Web-based publishing and the increasing use of the Web by both instructors and students at colleges and universities is just one of the profound changes that has occurred in electronic publishing and biology education over the past several years. Among the most significant changes, the technology necessary for electronic publishing and multimedia presentations—both hardware and software—has gotten dramatically faster, better, and cheaper. "There are things we can do now that we hadn't even dreamed of 5 years ago," Decker says. For example, the increased computing speed allows Gould to run a simulation that, in just 7 seconds, plots the age distribution and total size of a human population over the course of 100 years under various conditions.

And lower costs mean that more colleges and universities can afford to buy computers with CD-ROM drives and the other hardware needed for computer-based instruction, such as the projectors used for multimedia classroom presentations. Students, too, are more likely to own their own computers with appropriate hardware and software.

The reduction in cost, together with improved technology, Decker says, "is probably leading more and more people to think about using some kind of computer-mediated instruction." At Princeton, Gould says, "the main thing that has driven change in attitude toward the use of computers in teaching is e-mail." He credits the university administration's decision to provide every faculty member with a laptop computer and an Internet connection, as well as technical support for using the computer; it "really broke down the barriers" and showed people the potential of computer technology, he says.

Colleges and universities these days are increasingly likely to support and encourage the use of multimedia and the Web in teaching. Tangible support for those instructors who want to create their own computer-based teaching tools includes supplying authoring software to help people create Web sites or multimedia presentations for courses; establishing campus media centers where faculty can receive training in how to use new technology (both hardware and software) as well as learn about current thinking on the use of computers in pedagogy; and providing assistance from graduate students or faculty specialists who have expertise in using the technology. Some departments are even granting relief time to allow faculty members—who are often already overextended—the opportunity to develop computer-based course materials.

Indeed, some administrators are actively pushing their faculty to incorporate multimedia and the Web into their teaching. The University of California—Los Angeles, for example, recently declared that all courses must have Web pages, generating a furor among the faculty.

A transformed playing field

Despite the growing presence of multimedia and the Web in the classroom and on textbook publishers' radar screens, these technologies are still relatively new, and people are still trying to figure out the "rules" for their use in teaching and the economics surrounding them. Both traditional and "new media" publishing companies are concerned about business models for electronic publishing. "When you're dealing with multimedia it's not the 'sound science' of publishing books—it's step by step, and sometimes it's a swamp," says John Vondeling, publisher of Saunders College Publishing. John Jungck, a biology professor at Beloit College, in Beloit, Wisconsin, agrees. "We need to understand that entering into very dif-
different media transforms a great deal of the playing field," he says.

Jungck is a cofounder and editor of BioQUEST Curriculum Consortium, a nonprofit, grant-supported venture that promotes a research-oriented, problem-solving approach to the teaching and learning of biology. The consortium publishes the BioQUEST Library, an anthology of peer-reviewed, field-tested interactive multimedia modules that promote the "learning by doing" philosophy. Software in the library is provided as a CD-ROM under a licensing agreement that is coordinated by Academic Press, from whom subscribers can purchase either an individual user license or an annual site license.

The BioQUEST Library is just one example of the impact of electronic publishing on publishing in general. Traditional textbook publishers must compete with nonprofits, such as BioQUEST; with for-profit companies that specialize in multimedia and online publishing; and with professors who are developing their own Web sites and multimedia software.

Ron Appleby, new-media producer of science materials for McGraw-Hill Higher Education, says that the question of how to make electronic publishing pay off is a concern shared by all textbook publishers. Despite the considerable investment needed to produce multimedia CD-ROMs and Web sites and the difficulty of recovering these costs, he says, "if you don't have a CD or full-fledged Web site with your book, if you haven't made that investment, your book will not even be considered" by those doing the buying.

Struggling to stand alone

Most of the CD-ROMs being produced by textbook publishers fall into the category of what the publishing industry calls ancillaries—products such as overhead transparencies, slide sets, and teaching guides that are included as part of a package with a textbook and whose chief purpose is to increase textbook sales. Although some publishers offer the textbook and the CD-ROM separately, the two are frequently bundled together.

Indeed, most publishing companies are so far finding it difficult to successfully develop and market CD-ROMs as stand-alone products for several reasons. Unlike other ancillary materials, which are aimed at instructors, CDs are used by both instructors and students. And many textbook publishers are simply not sure about what types of stand-alone CD-ROMs to produce and how to market a product that is completely divorced from a textbook. "Publishers had so much invested in the textbook tradition that they've never known what to do with [people] like us who feel that...the textbook is the ancillary material rather than the software being ancillary to the book," Jungck says. Moreover, Decker says, because textbook publishers are producing and marketing CD-ROMs primarily as ancillaries, these companies usually cannot afford to invest the money needed to produce the high-quality multimedia materials that could sell on their own. "Also," he says, "there has to be some critical mass of users for textbook publishers to take the plunge in terms of producing really good quality stuff. It's almost a chicken-and-egg proposition."

Newer electronic publishing companies that focus exclusively on producing multimedia CD-ROMs or commercial Web sites are also struggling with how to market their products as stand-alone. Biologist and former department chair Bill Purves, one of the founding partners of The Mona Group, has developed a CD-ROM for students that "is keyed simultaneously to 11 of the introductory [biology] textbooks" on the market, he says, including his own textbook, Life: The Science of Biology. The CD-ROM, which includes text and accompanying graphics and animations, chapter reviews, and other review material, is intended to be sold as a stand-alone product; there is also an instructor's version of the CD for use in lectures. But so far sales have largely been limited to those disks that are being bundled with Purves' textbook, which, co-published by Sinauer Associates and W. H. Freeman.

Sinauer says that "marketing this CD-ROM is hard going.... Trying to sell it as a stand-alone product, we're not getting any universal acceptance.... It's not obvious that the world wants multimedia as much as we thought." His partner Purves is optimistic, however, noting that the timing of the CD-ROM's release was not ideal. "The big problem was that [the CD-ROM] came out too late in the spring for the marketing department to deal with. Faculty were already scattering for the summer," he says. Nevertheless, Purves says, his company believes that, at least in the short run, bundling CD-ROMs with textbooks is the most certain and fastest way to make a profit with multimedia products. The Mona Group is working on other CD-ROMs that can be bundled with texts (including a three-CD set that will come out in December 2000 along with the sixth edition of Purves' textbook), while keeping an eye toward marketing more stand-alone products in the future.

Chaput's company, Cogito Learning Media, publishes multimedia educational CD-ROMs that are intended strictly as stand-alone products. Like Purves, Chaput—who spent many years in traditional science publishing—says she founded her company because she believed that emerging technologies could be harnessed to improve the way students learn about science. Whereas The Mona Group has so far done most of its own content development and includes an artist and animator as one of its founding partners, Cogito operates more like what Chaput describes as "a classic but modern-day publishing company," in which the company contracts out much of the hands-on development work.

But unlike traditional publishers, Chaput says, Cogito does not "build things out of a print model." Although Cogito faces the challenge of trying to create high-quality educational material for a low price with-

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out the safety net of income from textbook sales, Chaput views the ability to focus exclusively on publishing stand-alone software as an advantage. Many traditional publishing companies, she notes, “are burdened by both the fact that they’re publicly held and have to produce quarter-to-quarter results, and by the fact that they have to keep print assets alive.” For these companies, she says, “much of their multimedia is not the purpose of their business, it’s an add-on.”

Nevertheless, Chaput and others believe that this situation will change as traditional textbook publishers devote more of their time, money, and energy to electronic publishing, including CD-ROMs and online services. Indeed, one of the issues that people involved in electronic publishing are facing is the impact of the Web’s rapidly increasing presence on college campuses over the last several years. Companies must now decide how much of their resources to put into developing CDs and other unalterable “fixed media” electronic products, versus creating online products. But in either case, they will have to figure out how to effectively market these products independent of, or in addition to, hard-copy books.

Electronic publishers also face other economic challenges. For example, material on CD-ROMs—like other software—can be copied illegally and passed from student to student. In addition, although copyright laws and licenses prohibit the resale of software, in practice some bookstores are buying and reselling software along with used textbooks. When it comes to the still newer realm of online publishing, the economic challenges are even more daunting. Almost no one has figured out how to make a profit from the Web, and most users expect free access to online material. Nevertheless, both established publishers and new companies such as Peregrine Publishing are turning their attention to online publishing, attracted by the Web’s growing popularity and accessibility.

A still-tangled Web?

On its Web sites, such as The Biology Place, Peregrine offers a variety of material for high school and college students and teachers, including interactive exercises, self-tests, and a range of tools to help instructors. Behnke says that the Web can help students by allowing them to collaborate and interact; it also offers the advantage of timeliness and currency because online material can be rapidly and easily updated, unlike fixed media products. “You’ve got to look at the medium for its unique properties and exploit those properties,” Behnke says, but adds: “That doesn’t mean it’s superior in all respects.”

Indeed, people who publish CD-ROMs point out that the Web still has bandwidth limitations that make it difficult, if not impossible, for users to download elaborate graphics, animations, movies, and simulations. The choice between CD-ROMs and the Web “depends on what you want to do,” Purves says. “What we wanted to do...was to [create] killer animations and movies and to provide great graphics, and even today, for most users, this stuff is a non-starter on the Web.”

But Behnke says that “there are a lot of things you can do on the Web that optimize content, even interactive content, so that it doesn’t require a lot of bandwidth.” And, he says, he is not convinced that elaborate multimedia materials are what work best for students—or even are what students are looking for. “There’s a difference between studying biology and playing a video game,” Behnke says, “and I think a lot of CD development has been motivated by standards that have been created with different uses in mind for the medium.”

Behnke says his company turned to Web-based publishing rather than CD-ROMs “because [the Web] is much more universally available to students and educators” than CD-ROM technology. The timing was also critical, he says, in that Peregrine was started in 1995, when the Web was already in its ascendency—a phenomenon that someone starting a company a few years earlier would not have been likely to predict. In addition, Behnke says, CD-ROMs must be distributed and sold through traditional channels, adding to the publisher’s costs. Indeed, he notes, Web publishing uses a different business model than either CD-ROM or book publishing. For a subscription fee payable by credit card, an individual student or a group of educators and their students can immediately access The Biology Place with a password, and “there’s no physical inventory or distribution process connected with that [access].”

The critical question that remains, however, is whether enough users are willing to shell out the money to access such online sites. Online publishers such as Peregrine are betting that the answer is yes. “We’ve long thought that as the Web becomes more and more an accepted medium and a valued medium for its currency and comprehensiveness, people will gladly pay” for access to online material that is professionally produced and of higher quality than much of what is available on the Web for free, says Ken Pratt, high school editor for Peregrine.

The average instructor does not have the time, money, or know-how to create high-quality material for the Web, Pratt says. And although some people in academia are developing excellent Web sites, he says that “there are some universities and colleges who are moving toward copyrighting their material, meaning that continued free access for all content may in fact be narrowing slightly.” Behnke thinks the fact that instructors are posting their own content on the Web and using the Web for their courses is “great...because I think educators recognize very readily the kinds of stuff they can do for their course and where they need commercial help.... The more educators that do that, the bigger the market for commercial resources.”

Issues for educators

Whereas in 1995 there were relatively few educational biology CD-ROMs on the market, and even fewer
of high quality, today many more biology CDs are available. But, as with print media, the quality of multimedia material still varies widely, and instructors must choose the products that best suit their purposes. And as instructors begin using electronic technologies in their teaching, they need to determine which technologies to use and how best to integrate these into their courses.

One of the oft-cited advantages of multimedia and Web-based teaching materials is that they are interactive, but the educational biology software that is currently on the market varies widely in its degree of interactivity. To be included in the BioQUEST Library, software must be judged to be highly interactive and to “emulate the research experience,” Jungck says. But Purves says his own experience shows that developing interactive scenarios and simulations that really engage and motivate the student and not just delight the instructor is not easy.

Decker says much of the commercially produced software he has seen “is so hard-wired, in the sense that the end user doesn’t have control.... [It’s] not clear what the purpose is and there is no flexibility in how you use it.” The best software, he says, engages the student in the learning process and gives the instructor the flexibility to customize the material—qualities he admits are hard to achieve. It is because relatively little commercial software meets these criteria, Decker says, that he and other educators have been producing their own software for use in lectures and for more interactive exercises.

But the sands in self-publishing may be shifting somewhat as publishers of electronic media begin talking more to educators and begin developing and marketing new types of products. Some textbook publishers, as well as companies that focus exclusively on electronic publishing, have approached people like Decker and his colleagues about the possibility of forming partnerships or collaborations in which the company would disseminate material originally produced in-house at colleges and universities. Publishers would likely carry out other functions, too, such as editing, peer-review, and technical support.

Appleby notes that traditional textbooks are also written by university faculty, but the copy editing, proofreading, quality assurance, and other steps in the production and distribution process are handled by the publishing company, which has the resources to perform these tasks. Similarly, he says, if someone at a university has great ideas and creates some good software, “that’s where the opportunity is for the publisher, because you can bring the production values and the editorial values to a piece of work that maybe a single author, even of multimedia, may not be able to do on their own.”

With the growing presence of multimedia and the Web on campus and, in some cases, increasing pressure to incorporate electronic media into teaching, instructors need to make sure they are using such software for the right reasons. “People are being pressed in many situations by a department or university to bring electronic media into the teaching of their course,” Chaput says. “Now, that may be a fad, and to me whether it’s a fad or it’s an enduring influence depends on the quality of what’s delivered,” she says. Appleby echoes this notion. “You can be very wowed by the technology, but without the content it doesn’t matter,” he says, adding that pressure to use electronic technology can also come from students, particularly from younger children who are part of “the Nintendo generation.”

Randy Moore, dean of the College of Arts and Sciences at the University of Louisville, uses multimedia in his teaching, primarily in lectures. But he points out that “multimedia is just a tool...and it can be misused.” Multimedia is not a magic bullet, he says, and it “can do harm if [the lecture] just becomes a picture show.” A bad teacher using multimedia, he notes, is still a bad teacher.

Although Moore, who is the editor of The American Biology Teacher, uses some multimedia in the lab setting as well, in general he prefers that students use their time in the lab to get their hands wet. “The understanding of life is the important thing,” he says. “There is no multimedia tool that can give students the texture of holding an animal. How does the animal feel? How does it feel to feel a heartbeat, or the texture of a leaf? There is no multimedia tool that can do that.”

Peering into the crystal ball

What does the future hold for electronic publishing and for the use of multimedia and the Web in biology education? What new technologies might spring up to replace or supplement the existing ones?

A transition from CD-ROMs to the Web is occurring already, although whether the Web will completely supplant CDs (and whether electronic publishing of textbooks may even replace print publishing) remains to be seen. Companies that now focus exclusively on CD-ROMs see a growing role for the Web in their futures, and some are already moving toward “hybrid products” that combine multimedia CD-ROMs with links to online material. At the same time, many textbook publishers are working with a combination of printed books; CD-ROM technology, which allows elaborate multimedia presentations; and the Web, which offers the advantages of timeliness, ease of updating, and easy access. For example, Appleby says, McGraw-Hill Higher Education has already created password-protected “Online Learning Centers” to accompany its textbooks, with features for both students and instructors. In addition, McGraw-Hill offers online products that allow various degrees of customization to help instructors create their own Web pages for courses.

One commonly mentioned scenario for the near future is that textbook publishers will create another type of hybrid product: slimmed-down texts with fewer illustrations and end-of-chapter materials, which students will use in combination with multimedia materials provided via CD-ROM or the Web. In other
words, Appleby says, books may not disappear, but they may change substantially in form and format.

If the bandwidth issue were to disappear, as many experts predict, CD-ROMs and other fixed-media products would likely be replaced completely by online material. (It is possible, however, that fixed media may always be faster than networks.) Some publishers of electronic media think that a more likely next step for multimedia publishing is the digital video disk (DVD), which stores much more information than a CD-ROM.

“We want to be working with the Web when it’s more capable,” Purves says. “In the meantime, some of our products are...straining the limits of the CD-ROM.” But, he notes, electronic publishers planning for the future face a dilemma analogous to that seen in the early days of CD-ROMs, in that very few people now have access to computers with DVD drives.

One thing is clear: Companies must figure out how to make electronic publishing profitable and develop new business models by which to do so if they are to survive. They must also try to predict what type(s) of electronic media are likely to predominate in the next 10 or so years and how institutions of higher learning, instructors, and students are likely to integrate these media into their education plans. In the meantime, companies are trying not to commit too many resources to any one electronic medium—but that stance may make it difficult for them to create top-quality material in any of these media.

Multimedia and the Web may be just another set of tools in the teacher’s toolkit, but they nevertheless appear to be here to stay. Some people in the publishing business, including Vondeling, envision a future in which electronic textbooks can be downloaded onto hand-held computers, providing “a new delivery system where you no longer will need paper, printing, binding, warehousing, [and] delivery,” he says. Other publishers and educators even speculate as to whether traditional lectures will go the way of the dinosaurs, with distance education and customized learning via the Web making biology education more accessible. The truth is that in the wild world of computer technology, nobody can predict for sure what the future will hold. But for those who are along for the ride—or even those who are witnessing things from the sidelines—this is an exciting time indeed.