Free textbooks and other open educational resources gain popularity

Affordable and customizable, they contribute to making higher education more inclusive and accessible.

Given a choice between paying $200 for a textbook or taking an equivalent course with a free textbook, what would you do?

The prices of college textbooks have skyrocketed: From 2011 to 2018, they went up by 40.6% in the US, according to the Bureau of Labor Statistics' Consumer Price Index. That can add up to as much as $1000 for a single semester. So it's no surprise that freely available, openly licensed textbooks, lectures, simulations, problem sets, and more—known collectively as open educational resources (OERs)—are having a moment.

Last year, for the first time, more than half of US college faculty reported "some level of awareness" of OERs, finds Bay View Analytics, a company that conducts research at the intersection of technology and education.

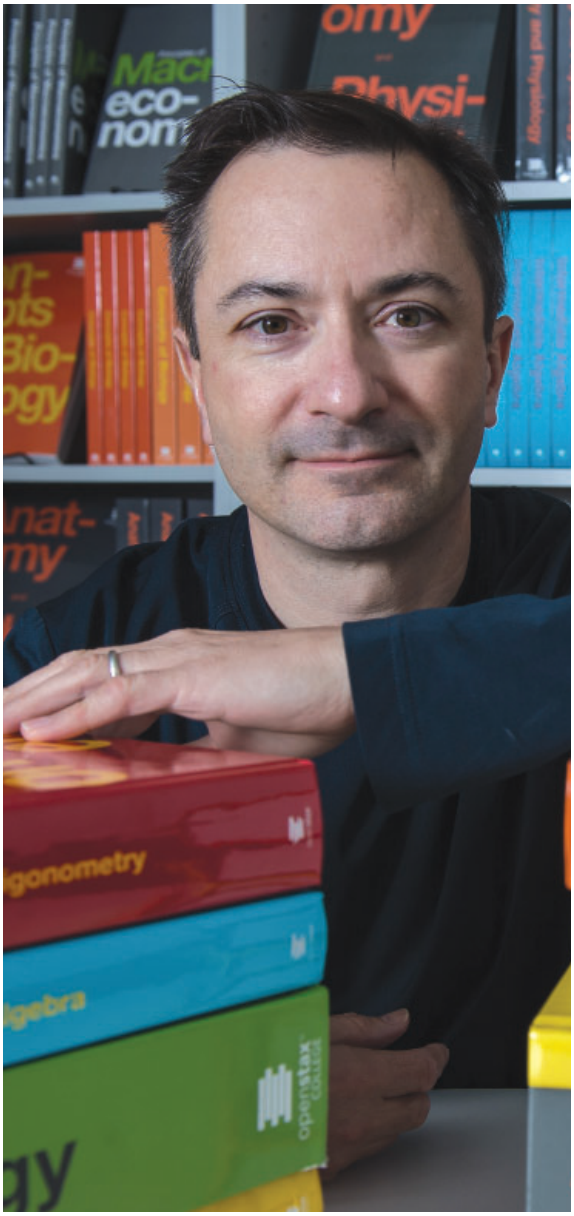
A major player on the OER scene is OpenStax. Based at Rice University, the initiative currently has more than 60 titles focused mostly on large introductory college courses. "They have revolutionized the OER market," says Jeff Seaman, Bay View's director. OpenStax put out its first textbook in 2012, for algebra-based physics. In spring 2022 OpenStax announced that its introductory astronomy textbook was the US leader. In less than a decade, several OpenStax textbooks have risen to third through fifth place in their markets, says Seaman. "No other publisher has had that growth." From its origins in introductory-level college classes, OpenStax is moving down to the high school and up to upper-division levels.

Around the turn of the millennium, various forms of OERs got started, including Wikipedia; shared lectures, such as MIT's OpenCourseWare; and online science simulations from the University of Colorado Boulder known as PhET. OpenStax grew out of a predecessor that Richard Baraniuk, a professor of electrical and computer engineering at Rice, started in 1999. At the time, he wanted to offer his students a better, customizable textbook. "Instead of thinking of books as glued-together pieces of paper," he says, "we could think of them as Lego bricks" by taking advantage of the Web.

Free, open textbooks have "taken off much faster than I expected," says Baraniuk. He estimates that to date, students have saved nearly $2 billion by using OpenStax books instead of buying comparable traditional textbooks. And being free is not the only selling point for open textbooks and OERs more broadly: In the past few years, says Lauren Woolsey, who teaches physics and astronomy at Grand Rapids Community College in Michigan, "the messaging has shifted to the role they can play for social justice and equity."

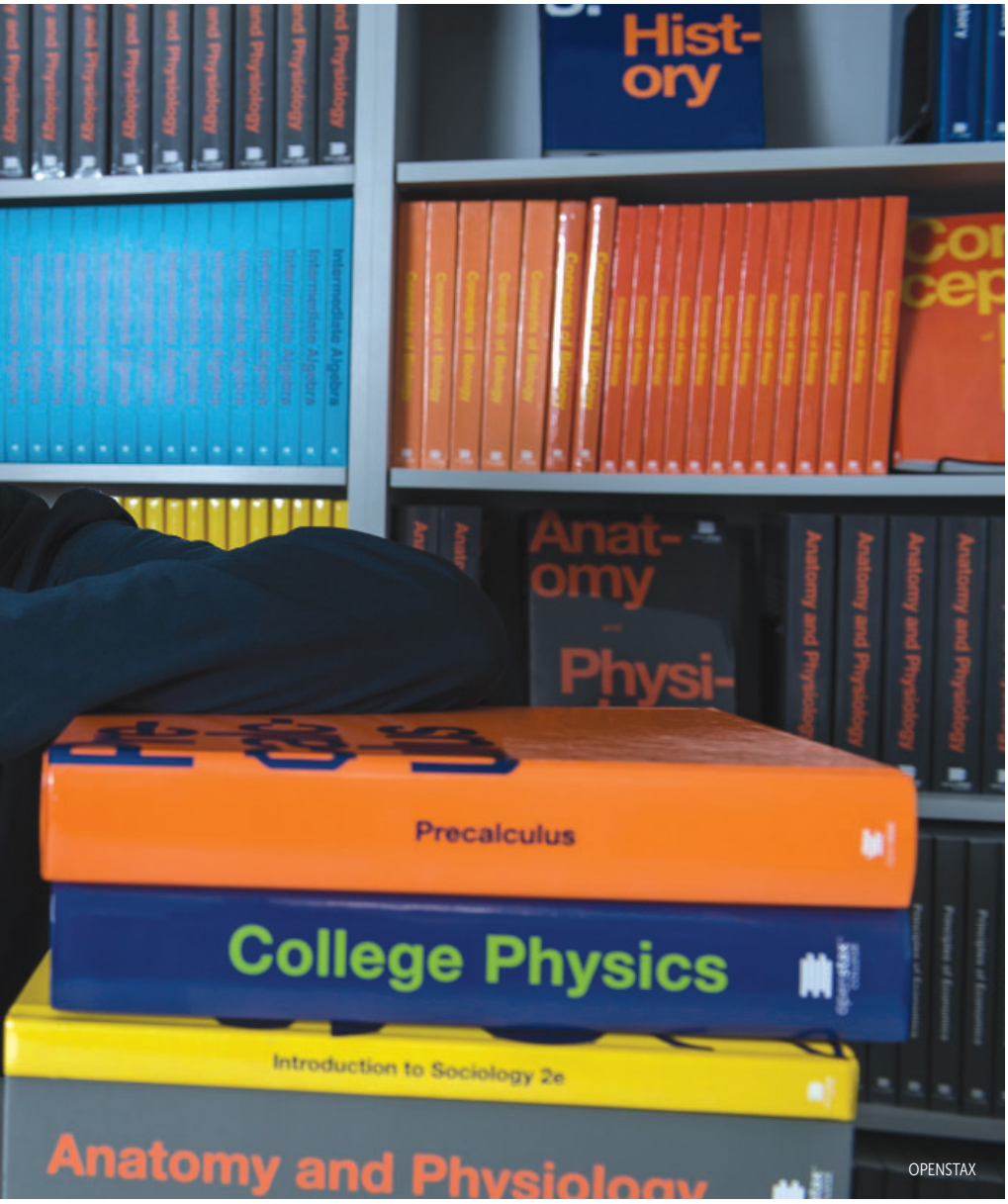
Evolution revolution

"Our resources are extensively peer reviewed and copyedited, and interactive elements are checked," says OpenStax editor-in-chief David Harris, who previously worked at three major traditional publishers. OERs are typically published under a Creative Commons license, which can take several forms but generally allows material to be legally used, adapted, translated, and shared by anyone anywhere. Because it's open source, says Harris, "we have to create most of the lavish drawings and illustrations ourselves." The total cost to make a new textbook comes to $500 000 to $1 million, he says. OpenStax is funded mostly by philanthropies, with the William and



Flora Hewlett and Bill and Melinda Gates Foundations being among the main givers.

OpenStax books are similar in content and scope to their traditional counterparts, Harris says. One reason is to ease the switch to OERs for instructors and institutions. But there are differences: As digital textbooks, OpenStax publications can be updated regularly and cheaply. And unlike digital textbooks from traditional publishers, users can download searchable electronic versions, which is especially helpful if their internet is unreliable. (About 7% of students order print versions of OpenStax textbooks, the publisher says. They cost $25 to $50—much less than tradi-



OPENSTAX FOUNDER AND DIRECTOR RICHARD BARANIUK with a selection of hard-copy versions of open textbooks. The publisher says that more than 23 million students have used its resources since 2012.

tional textbooks—to cover printing expenses.) And OpenStax and other open textbooks often link to open-source educational materials, including videos and such interactive simulations as PhET. Many of the books have an associated online site where instructors can share ancillary materials.

OpenStax authors are paid a fixed amount—there are no royalties. Few authors strike it rich writing textbooks, says Harris. "Under our model, everyone understands how much they'll be paid." The vast majority do it for the OER mission, he adds. "We have authors coming to us."

Andrew Fraknoi, a professor at the Fromm Institute of the University of San Francisco, is lead author of the OpenStax astronomy textbook. "Teaching introductory astronomy is one of the most profound ways that the astronomy community influences the public," he says. "Students will be the next generation of teachers, congressional representatives, taxpayers, and parents. This is important work."

The digital versions of traditional textbooks—the top publishers are Pearson, Cengage, and McGraw-Hill—are cheaper than their hard-copy counterparts. And commercial publishers are trying to stem their loss of market share to open textbooks. For example, most of them offer "inclusive access" packages. They offer multiple textbooks and bundle electronic textbook access together with quiz and homework platforms. Such packages are often wrapped into tuition fees, making textbook costs difficult to disentangle or opt out of. On request, some traditional publishers sell portions of hard-copy books. And they let users rent electronic textbooks individually or as a suite of titles, with leasing times that vary from a single semester to life.

The COVID-19 pandemic helped with the switch to digital textbooks, says Jonathan Perry, a physics instructor at the University of Texas (UT) at Austin. "Why use OER? All textbooks are imperfect. They all have flaws. So why not use the one that is free and accessible?"

Customizing and sharing

Jennifer Kirkey is a physics instructor at Douglas College in British Columbia, Canada. "I'd been sort of aware of OER," she says, but a "light-bulb moment" came about 10 years ago when she realized she could customize the open textbooks. "I was tired of the textbook publishers forcing my pedagogy by what they publish," she says.

Members of Kirkey's department jointly created their own versions of OpenStax textbooks. They slashed a lot, turning 30 chapters into 10, she says. "Students can be scared, math phobic, so being able to give them a smaller book was better than saying, 'Skip these sections.' "

They also significantly broadened the cultural context in both the astronomy and algebra-based physics OpenStax textbooks, Kirkey says. "We added examples from many cultures, including First Nations of Canada, to make them more visible. We removed the implicit assumptions that everyone knows minutiae about baseball and football." The US versions talk about American astronauts, she adds. "We include examples from Canada and other countries."

Grand Rapids Community College's Woolsey says that using OERs improves her teaching. "I don't feel tethered. I am

STUDENTS AT DOUGLAS COLLEGE in British Columbia regularly hold "tabling" events to advocate for free textbooks. They collect students' textbook receipts and shout out to professors who use open textbooks.

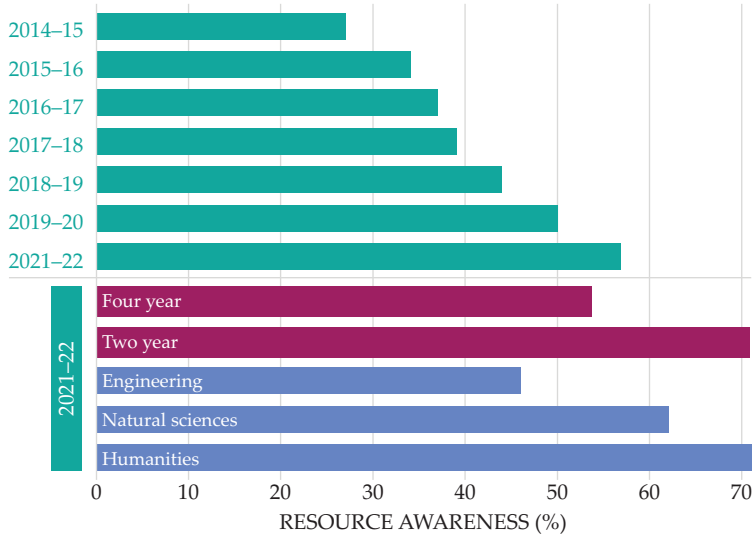
more free with assignments and in how we veer into material that comes up," she says. "If I were assigning a $200 textbook, I'd feel I had to use it enough to justify the cost."

Woolsey posts slides, videos, and problem sets on the astronomy instructors' hub at OER Commons, a public digital library for educators. "No one has to reinvent the wheel when we have a collaborative spirit," she says. "I like helping other instructors get started. And they have the built-in right to edit."

Affordability, equity, access

Rajiv Jhangiani, a psychology professor at Brock University in Ontario, Canada, has authored open textbooks, advocated for them at the United Nations, and researches their efficacy. When students can see in the course catalog that classes will have a free textbook, enrollment and course completion rates both increase, he says. "Affordability is important for equity and access in higher education."

As long as students have access to the course textbook, their performance doesn't depend on whether textbooks are free, Jhangiani says. But when buying textbooks is a stretch, students go without or resort to pirating, sharing, or pilfering library copies, says Ann Fiddler, director of open education at the City University of New York (CUNY), where she oversees the 25-campus system's OER program. "They come in to the library with razor blades and steal pages from lab books," she says, adding that for some



AWARENESS OF OPEN EDUCATIONAL RESOURCES is growing among US-based higher-education instructors and exceeded 50% in spring 2022. Awareness was highest in the humanities (73%) and lowest in engineering (46%). In the natural sciences, it was 62%. It was also notably higher in two-year institutions (71%) than four-year ones (54%). Data are from annual surveys conducted by Bay View Analytics and averaging 3000 instructors.

Selected resources

- The Open Education Network, https://open.umn.edu/oen, works to make higher education more accessible. It hosts the Open Textbook Library, https://open.umn.edu/opentextbooks, which currently offers more than 1200 open textbooks.
- In addition to providing open licensing, Creative Commons runs programs to train and spread the word about sharing knowledge, https://creativecommons.org.
- "Twenty years of Open Educational Resources: Building robust networks for innovation," by Angela DeBarger and Cathy Casserly for the William and Flora Hewlett Foundation, 7 October 2021, https://hewlett.org/twenty-years-of-open-educational-resources-building-robust-networks-for-innovation.
- The Community College Consortium for Open Educational Resources provides materials and support, https://www.cccoer.org.
- The Mason OER Metafinder conducts real-time searches across many sources, https://oer.deepwebaccess.com.
- The multi-institutional LibreTexts project produces open textbooks, including in physics, https://phys.libretexts.org.
- MIT offers lectures and course materials for thousands of its undergraduate and graduate classes at OpenCourseWare, https://ocw.mit.edu.
- PhET offers a large selection of free, interactive math and science simulations, https://phet.colorado.edu.
- Walter Lewin's lectures on YouTube claim they'll make viewers ❤ physics, https://www.youtube.com/@lecturesbywalterlewin.they9259.
- HyperPhysics explores many physics concepts, http://hyperphysics.phy-astr.gsu.edu.
- Crash Course posts freely available educational videos for high school and college levels on YouTube, https://thecrashcourse.com.
- The oPhysics site offers a collection of interactive physics simulations, https://ophysics.com.
- Some 250 libraries and academic organizations in North America belong to SPARC, a nonprofit advocacy organization that supports open educational resources. It tracks US state policies at https://sparcopen.org/our-work/state-policy-tracking.

students it comes down to choosing between paying for a textbook, food, or rent.

When free textbooks are available for full degree programs, it's known as ZTC, or zero textbook cost. The institution benefits, says Jhangiani. "There are fewer withdrawals and the institution doesn't have to refund tuition."

Although adoption of OERs at the college level is largely up to individual instructors and departments, some systems of higher education and states promote it. The majority of campus OER initiatives are led by libraries. (At the K–12 levels, adoption of OERs is a matter of appealing to schools or school districts.)

British Columbia started an open-textbook project across public higher education in 2012. In 2021 California awarded its community college system $115 million over five years to develop ZTC programs. And in 2016 CUNY was among 38 community colleges nationwide that received grants totaling $8 million from the nonprofit organization Achieving the Dream for the same goal.

New York State gives CUNY and the State University of New York each $4 million annually for OERs. The money goes largely toward incentivizing faculty to convert their courses to OERs, says Fiddler. For a small stipend, many faculty will switch, she says. "And when we come across resistance, we move on. We don't proselytize." So far, 15–17% of courses in the CUNY system use open textbooks, she says. The goal is 100%, she adds. "We've saved more than $100 million in student textbooks in the last five years."

Upping the uptake

Uptake of OERs is growing: In 2021–22, 22% of US faculty surveyed by Bay View said they used OER materials for their largest enrollment course, up from 5% in 2015–16. In other countries, adoption may be higher. MIT's OpenCourseWare and Colorado's PhET, for example, are both used more internationally than in the US.

A barrier to adopting OER materials is inertia—instructors have textbooks and other resources they are used to. Another is the scattered distribution of OERs, which can complicate identifying and finding materials. Others include a mismatch of learning management systems, the narrowed price gap when traditional textbooks include homework management systems, a perception that something that is free won't be as good as something one pays for, and time.

"We might have faculty who quickly locate an OpenStax textbook," says James Glapa-Grossklag, dean of learning resources at College of the Canyons in Santa Clarita, California. "But some of the book doesn't speak to the local curriculum, local needs, or local identities." Adapting a textbook takes time, he continues. "Faculty don't have time, and their institutions usually don't recognize adapting a book as contributing to their tenure packet." That's starting to change, with some institutions, such as the University of British Columbia, revising their tenure and promotion policies to recognize such efforts.

Some instructors and students complain that OpenStax books can be verbose and that they don't offer enough practice problems. Those issues come up with commercial textbooks, too. With OpenStax, though, they could be addressed through adapting the text, the publisher notes, but many instructors don't get around to doing that. "I have not dug in to modify a text," says UT Austin's Perry. "I'd like to, but it's work and time."

Another common concern relates to the paucity of such ancillary materials as question banks and tutorials. That was more of a problem earlier on, says Jhangiani. The OER content producers are giving "more attention in the past few years to ancillary materials."

The goal of OERs is to provide greater access to higher education for more people, says Glapa-Grossklag. "That goal contributes to a functioning democracy and equitable society."

Toni Feder