

The Best Things in Life Are Free – And That Includes Math Books

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Which “Free” Are We Talking About?

Wiktionary has nine definitions for the adjective **free**, having in turn 18 sub-definitions¹. In particular, two meanings that English² conflates are:

- **obtainable without any payment**; we say “free as in ‘*free beer*’,” and
- **unconstrained, unfettered, unhindered**; “free as in ‘*free speech*’.”

Maybe better examples for the mathematical community are:

- “Morse Theory is free at my office” ... meaning: I am happy to have unfettered conversations there about this beautiful subject
- “**Morse Theory** is free at my office,” ... meaning: I have copies of John Milnor’s book of that title which I distribute, free of charge, at my office.

In this talk, I mean **free** in *both of those meanings*.

¹ “free”, by Wiktionary contributors, <https://en.wiktionary.org/w/index.php?title=free&oldid=52257548>, released under a Creative Commons Attribution-ShareAlike License

² but not many other languages!

Or We Could Wimp Out And Use “Open”

The *free speech/beer* metaphor dates to beginnings of the **free software movement**, where it was coined by Richard Stallman.

In an attempt not to scare away business people, Eric Raymond chose instead to use the phrase *open-source software*.

A good compromise is **FLOSS**, for **Free/Libre/Open-Source Software**.

Whether Stallman or Raymond was right, FLOSS has taken over the world: think of **Android**, **Linux** [maybe the most widely used operating system in the world], **Firefox**, **MediaWiki** [the engine that runs **Wikipedia**], **Apache** [the most widely used web server software in the world], *etc.*

E.g., when I worked for IBM Research in the early 00s, my youthful radical background in FLOSS was a benefit, not a problem.

The community as a whole has gone with the [wimpy] approach and talks about **Open Educational Resources** or **OER**.

What Are Open Educational Resources [OER]?

HB18-1331, Higher Education Open Educational Resources, passed by the Colorado General Assembly and signed by Governor Hickenlooper on 30 April 2018, defined OER here:

(6) "OPEN EDUCATIONAL RESOURCES" MEANS HIGH-QUALITY TEACHING, LEARNING, AND RESEARCH RESOURCES THAT RESIDE IN THE PUBLIC DOMAIN OR HAVE BEEN RELEASED UNDER AN INTELLECTUAL PROPERTY LICENSE THAT PERMITS FREE USE OR REPURPOSING BY OTHERS AND MAY INCLUDE OTHER RESOURCES THAT ARE LEGALLY AVAILABLE AND AVAILABLE TO STUDENTS FOR FREE OR VERY LOW COST. OPEN EDUCATIONAL RESOURCES MAY INCLUDE FULL COURSES, COURSE MATERIALS, MODULES, TEXTBOOKS, FACULTY-CREATED CONTENT, STREAMING VIDEOS, EXAMS, SOFTWARE, AND OTHER TOOLS, MATERIALS, OR TECHNIQUES USED TO SUPPORT ACCESS TO KNOWLEDGE.³

³Closed based on the [William and Flora Hewlett Foundation](https://www.williamflora.org/)'s definition: "OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge."

First Answer: Free Textbooks

Let's highlight two words here

(6) "OPEN EDUCATIONAL RESOURCES" MEANS HIGH-QUALITY TEACHING, LEARNING, AND RESEARCH RESOURCES THAT RESIDE IN THE PUBLIC DOMAIN OR HAVE BEEN RELEASED UNDER AN INTELLECTUAL PROPERTY LICENSE THAT PERMITS **FREE** USE OR REPURPOSING BY OTHERS AND MAY INCLUDE OTHER RESOURCES THAT ARE LEGALLY AVAILABLE AND AVAILABLE TO STUDENTS FOR FREE OR VERY LOW COST. OPEN EDUCATIONAL RESOURCES MAY INCLUDE FULL COURSES, COURSE MATERIALS, MODULES, **TEXTBOOKS**, FACULTY-CREATED CONTENT, STREAMING VIDEOS, EXAMS, SOFTWARE, AND OTHER TOOLS, MATERIALS, OR TECHNIQUES USED TO SUPPORT ACCESS TO KNOWLEDGE.

So OER include free textbooks [in the sense of *free beer*].

Students tend to like this *a lot*, and it changes their behavior in many ways.

Second Answer: “Repurposing by Others”

But notice this also includes

(6) “OPEN EDUCATIONAL RESOURCES” MEANS HIGH-QUALITY TEACHING, LEARNING, AND RESEARCH **RESOURCES THAT** RESIDE IN THE PUBLIC DOMAIN OR **HAVE BEEN RELEASED UNDER AN INTELLECTUAL PROPERTY LICENSE THAT PERMITS** FREE USE OR **REPURPOSING BY OTHERS** AND MAY INCLUDE OTHER RESOURCES THAT ARE LEGALLY AVAILABLE AND AVAILABLE TO STUDENTS FOR FREE OR VERY LOW COST. OPEN EDUCATIONAL RESOURCES MAY INCLUDE FULL COURSES, COURSE MATERIALS, MODULES, TEXTBOOKS, FACULTY-CREATED CONTENT, STREAMING VIDEOS, EXAMS, SOFTWARE, AND OTHER TOOLS, MATERIALS, OR TECHNIQUES USED TO SUPPORT ACCESS TO KNOWLEDGE.

So OER also include resources which can be adapted, mixed with other OER, and then shared back to the global scholarly community.

Faculty tend to like this, and it changes their behaviors in interesting ways.

[Micro]Economic Issues for Students

The #RealCollege Survey found⁴ in 2017 that for university students

- 36% were food insecure in the 30 days before taking the survey,
- 36% were housing insecure in the last year, and
- 9% were homeless at some point in that year.

[Figures increase by about one third for community colleges.

Students face these economic burdens at the same time that tuition is going up faster than inflation [as the cost of “public” higher ed is more and more born by the individual students].

Then a class a student needs or wants requires an expensive textbook – \$100, \$200, \$300, or even \$400 is not unknown today.

Now ask yourself: if you were a student in debt, [sometimes or often] hungry, and concerned about keeping a roof over your head ... where would your economic priorities be?

⁴ *Still Hungry and Homeless in College*, Goldrick-Rab, Richardson, Schneider, Hernandez, and Cady, 2018, on the web [here](#).

[Macro]Economic Issues for Students

These individual decisions students make are happening in the context of other financial burdens increasing steeply on students. The result is well known:

total student debt in the U.S. exceeds \$1.5 trillion.

Some examples in Colorado:

Institution	Avg Debt, 2014 Grads
CSU-Pueblo	\$29,914
MSU, Denver	\$28,468
Colorado College	\$19,756
University of Denver	\$29,050
All private[non-profit] and public 4-years in CO	\$25,064

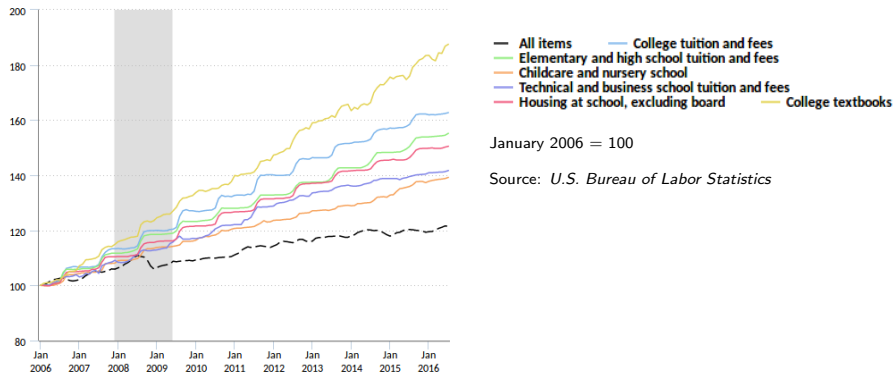
2014 is most recent complete data available

Average debt of 2017 CSU-FC grads was \$26,348

Source: <https://ticas.org/posd/state-state-data-2015#>

Students Pay Many Different Costs...

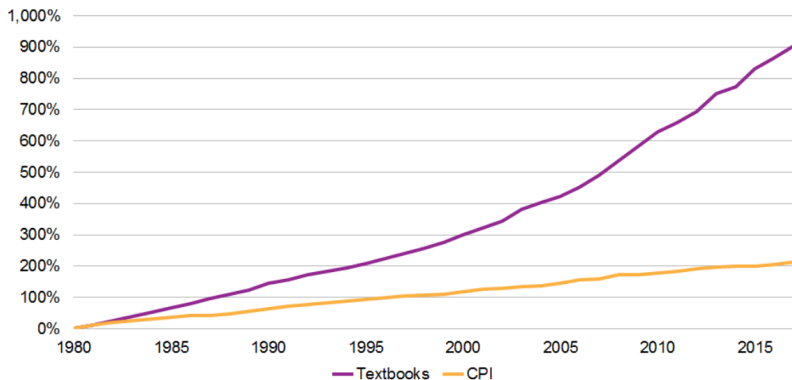
**Consumer price indices for tuition and school-related items,
not seasonally adjusted, January 2006-July 2016**



<https://www.bls.gov/opub/ted/2016/college-tuition-and-fees-increase-63-percent-since-january-2006.htm>

...But the Winner⁵ Is: Textbook Cost

Increase in textbook costs since 1980

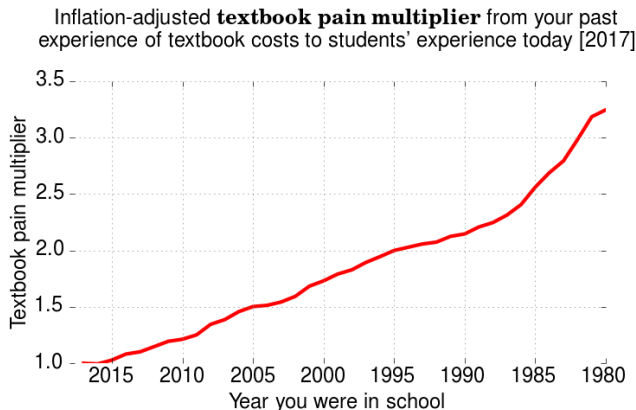


Source: U.S. Bureau of Labor Statistics

⁵ in terms of rate of growth, not absolute size

Your Intuition for Textbook Costs is Wrong

One attempt to correct our intuition for these different rates of inflation:



Source: <https://mathematikoi.net/>

But **Why** Do Textbooks Cost So Much?

A broken market mechanism: faculty choose, students pay. Publishers understand this.



Consequences for Students

Studies⁶ have shown that, as a result of these economic realities, students

- make decisions about which courses to take based on the costs of the textbooks;
- take fewer courses because of expensive textbooks;
- do not buy even required textbooks, because of cost, and therefore learn less, do more poorly, and drop out more frequently; and
- take longer to complete degrees because of the obstacle of textbook cost.

A particularly exciting recent study⁷ found that **DFW rates went down by one-third among minority and Pell-eligible students in gateway courses which switched from commercial textbooks to OER.**

⁶ See references in *Report to the Joint Budget Committee and The Education Committees of the General Assembly – Open Educational Resources in Colorado*, Brown-Sica et al., 2017, on the web [here](#).

⁷ *The Impact of Open Educational Resources on Various Student Success Metrics*, Colvard, Watson, and Park, *International Journal of Teaching and Learning in Higher Education* (2018), on the web [here](#).

Scholarly Production Wants to Be Free

Faculty are not used to thinking of the economic consequences of their choices, nor of their work as being in a marketplace⁸.

We are used to signing over our copyrights on research papers to the journal publishers, who in turn make large profits on subscriptions which they in no way pass on to the article authors.

Scholars do tend to keep the copyrights on their monographs and textbooks, although usually tied up in restrictive contracts.

It is as rare as winning the lottery (or getting struck by lightning) that a book will sell enough to make some serious money for the author.

Scholars mostly seek **impact**, which comes when others use a work in new ways – clearly without first asking permission. We **hope** someone else will take our ideas, with attribution!, and do something amazing.

In this sense, scholarly production wants to be **free, as in speech**.

⁸ other than “the marketplace of ideas”

Freedom Includes the Right to Seek a Profit, or Not

If a professor wants to assign an expensive textbook in a class (and has a good reason to do so) or wants to publish a textbook commercially with the hope of writing the runaway bestseller on economic history, then by academic freedom and scholarly tradition, we should not stand in the way.

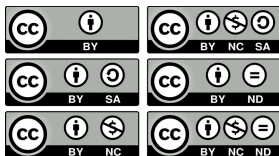
But usually, many faculty will be happy to contribute their textbooks, problem banks, software, and other writings to a global intellectual commons, a *Creative Commons*.

If there were a way to dedicate a creative work to this commons, rather than having it automatically fall into the domain of *all rights reserved* copyrights – as any work of original expression does as soon as it is fixed in a tangible medium⁹ – many scholars would likely do so.

⁹ this is the trigger which causes a copyright to spring into existence: no registration or formalities is actually required.

Creative Commons Licenses

The way to bend copyright law to the purposes of the scholarly life is to release works with a **Creative Commons Licenses**:¹⁰



Educational resources release with a CC license – well, **not** those two licenses with “ND” – are open to REPURPOSING BY OTHERS, in the words of [HB18-1331](#), and therefore are **Open Educational Resources [OER]**.

OER can be customized, localized, adapted to a faculty member’s own way of teaching, unlike [commercial] textbooks under traditional copyright.

Only OER truly respect an instructor’s academic freedom!

¹⁰ see <https://creativecommons.org>

Where Are OER?

This is not just a beautiful dream: scholars around the world are constantly producing a huge variety of OER, which can be found in many places:

- web pages
 - for some individual's personal work, e.g.,
<http://www.poritz.net/jonathan/share/>
 - for a particular OER e.g., <http://www.introtoie.com/>
- repositories, including those run by
 - ⇒ universities, e.g., <https://www.csupueblo.edu/library/services/faculty-support/scholarship.html>
 - ⇒ disciplinary organizations, e.g.,
<https://aimath.org/textbooks/>
 - ⇒ several NGOs, e.g., <https://open.umn.edu/opentextbooks/>,
<https://openstax.org/>, <https://rebus.community/>, etc.
 - ⇒ OER-promoting state offices, e.g.,
<https://www.floridashines.org/orange-grove>

An Issue for Math OER: Difficult Typesetting

$\text{\LaTeX}$ was FLOSS even before Stallman dreamt of free-speechifying beers!

Today, we mostly share $\text{\LaTeX}$ output in PDF form. But *PDF is where OER go to die*, it is said (because PDFs are so hard to modify). So it is important to share also your $\text{\LaTeX}$ source files. There are several ways to do this. One is **Overleaf** – e.g., [Kenneth Monk's Calculus I book](#). Another is just to build a web page with all the files – e.g., [the page for my number theory book](#).

Many OER are produced today in **Pressbooks**, a WordPress extension that many people like. Like other websites, this can use the **MathJax** Javascript library to make beautiful output easily (if you know $\text{\LaTeX}$).

There is also a tool called **PreTeXt** (see <https://pretextbook.org/>) which is probably better (ask me why, later) – see, e.g., [More Discrete Mathematics: via Graph Theory](#) by UNC's Richard Grassl and Oscar Levin.

Another Issue for Math OER: Interactivity and Ancillaries

Nowadays, there is a trend towards ebooks having interactive features (about which I have mixed feelings .. but it is definitely a trend). There are nice tools which can be used in web-based OER that do this, including things like [Desmos](#) and [H5P](#).

Probably more important because of the current model for delivery of math instruction, is online homework systems. Here the MAA has come to the rescue: it supports a wonderful tool called **WeBWork** (see webwork.maa.org) which is a bit intimidating but amazingly effective in practice. Brenda Forland of our region (based at Red Rocks Community College) has done some amazing things with it, which she recounted in a wonderful webinar which the CO OER Council¹¹ sponsored (and recorded!).

¹¹ an entity created by the CO HB18-1331 quoted above that works with the Colorado Department of Higher Education to support OER efforts in our state with, e.g., a conference and (small) grant program

What You Can Do **Now**, part 1

Students: advocate for OER! ... but carefully! Talk to me individually about how.

Faculty: first of all, please promise me you will use OER unless absolutely no acceptable one exists, or can be created [or adapted from existing ones]! Remember

- \$1.5**trillion** in student debt
- 10% homelessness
- increased academic freedom
- textbook costs increase at three times the rate of ambient inflation
- OER adoption yields $\frac{1}{3}$ decrease in DFW rate for students from traditionally underrepresented groups

How often in your professional life have you had the chance to make the world a noticeably better place, in a way which existing structures (academic freedom) empower you to do even if others want to stop you?

What You Can Do **Now**, part 2

More for faculty:

- start and OER committee on your campus
- talk to your librarian colleagues (they have super-powers)
- watch Brenda Forland's webinar on WeBWork:
<https://youtu.be/oMY60vqIQ0Y>
- go to OER conferences ($\exists$ many such)
- apply for OER grants ($\exists$ many such)

For the last two of the above, Coloradans should look at this site:

<https://masterplan.highered.colorado.gov/oer-in-colorado/>

Questions, Comments, and Contact Info

Questions? Comments?

Also feel free to contact me at jonathan@poritz.net .

Get these slides at <http://poritz.net/j/share/OER4RMSapril2019.pdf> and all files for remixing¹² at <http://poritz.net/j/share/OER4RMSapril2019/> .

If you don't want to write down that full URL, just remember

poritz.net/j/share or

poritz.net/jonathan/share or even just

poritz.net/jonathan .

¹² subject to CC-BY-SA