Spring 2020 ColoMATYC Conference
Open Educational Resources for Mathematics: the First 2,500 Years

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These slides can be found at https://poritz.net/j/share/OER4ColoMATYC

Some Roots of **Open**: A Morality Play...

The School of Athens by Raffaello Sanzio



Image in the public domain: Raffaello died in 1520. Original in the *Stanza della Segnatura* in the Vatican. This version: https://commons.wikimedia.org/wiki/File:%22The_School_of_Athens%22_by_Raffaello_Sanzio_da_Urbino.jpg.

Pythagoras[1]: Keeping Knowledge Secret on Pain of Death



He didn't prove or originate "his" theorem.

The *Pythagoreans* were quite like a *cult*, with odd dietary restrictions, belief in their leader's magical powers (talking to animals, *etc.*), divided as:

- *mathematikoi* ["learners"] who lived apart and knew hidden mysteries (*e.g.*, that $\sqrt{2}$ is irrational);
- *akousmatikoi* ["listeners"] who lived with their families and only aspired to greater secrets.

Hippasus of Metapontum, a renegade *mathematikos*, was tracked down and executed for the crime of revealing to the public that $\sqrt{2}$ is irrational.

[Pythagoras himself was killed when unwilling to step into a bean field despite being pursued by an angry mob.]

[1] born ≈570BCE, Samos, died ≈495BCE, Croton

Euclid[3]'s Radical Openness

His *Elements of Geometry* had more editions and influence than any other book [in the West; other than the Christian Bible].
The Elements was loved by Galileo, Newton, Hobbes, Spinoza, Descartes, Abraham Lincoln, Albert Einstein ... and many, many others[2]
For hundreds of years [in the west] it was a right of passage in the education of [yes, male and elite] young people to master *The Elements*.



The Elements was so influential because it was completely open, laying out all of its Theorems **with proofs** [including one that $\sqrt{2} \notin \mathbb{Q}$].

Proofs are like like the source code if a theorem were a program: Yes, Euclid was doing FLOSS [free/libre/open-source software] more than 2K years before the invention of the computer!

[2] *E.g.*, In *Moby Dick*, Melville says that the difficulty of whales mentally putting together the two images perceived by their widely separated eyes must be as if a human were "simultaneously to go through the demonstrations of two distinct problems in Euclid."

[3] mid-4thC to mid-3thC (BCE), Ptolemaic Alexandria

Open's Antiquity ... and Skipping to Early Modernism

Conclusion: while **Closed** has had very good PR, **Open** has a proven track record of scholarly and educational success and influence.

Additionally, **Open** as a scholarly practice did not start with the founding of `reddit`, or with Linus Torvalds or Richard Stallman or Larry Lessig. Instead it has a long a beautiful history.

To see the roots of the momentum swinging back against **Open** [in the West], let's skip past a few uneventful years (rise and fall of the Roman Empire, the Black Death, the Renaissance – wait: Hi, Raffaello! – the Protestant Reformation, *etc., etc.*), until the beginnings of classical Liberalism and Capitalism as the *ancien régime* started to crumble....

The idea [of people like Adam Smith] was to motivate people to do the "right things" in society by market forces: the whole dynamic of Capitalism with its producers always pressured to make better goods because consumers vote with their feet for the best products, by walking over to the purveyors of those better versions.

The Copyright Clause

Article I, Section 8, Clause 8. the *Copyright Clause*, of the US Constitution, gives Congress the power

> *"To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."*

This *exclusive Right* includes: performance, public display, copying, distribution, and creation of derivative works.

See my Copyright Cheat Sheet For University Faculty for one academic's[4] explanation of many aspects of copyright law.

The *limited Times* have been changed – extended! – again and again by Congress. Currently in the US, copyrights last for the life of the author plus 70 years ... but there are many details to consider, including exceptions such as *fair use*.

[4] Not a lawyer!

Yes, Milton, Markets Can Fail 1

A bookshelf in my office at the math department at CSU Pueblo, containing mostly books[5] I used as an advanced undergrad and grad student.



[5] And some juggling equipment.

Yes, Milton, Markets Can Fail 2

Books sent to me, for free, without my asking, by textbook publishers [thrown under a side table]:



Yes, Milton, Markets Can Fail 3

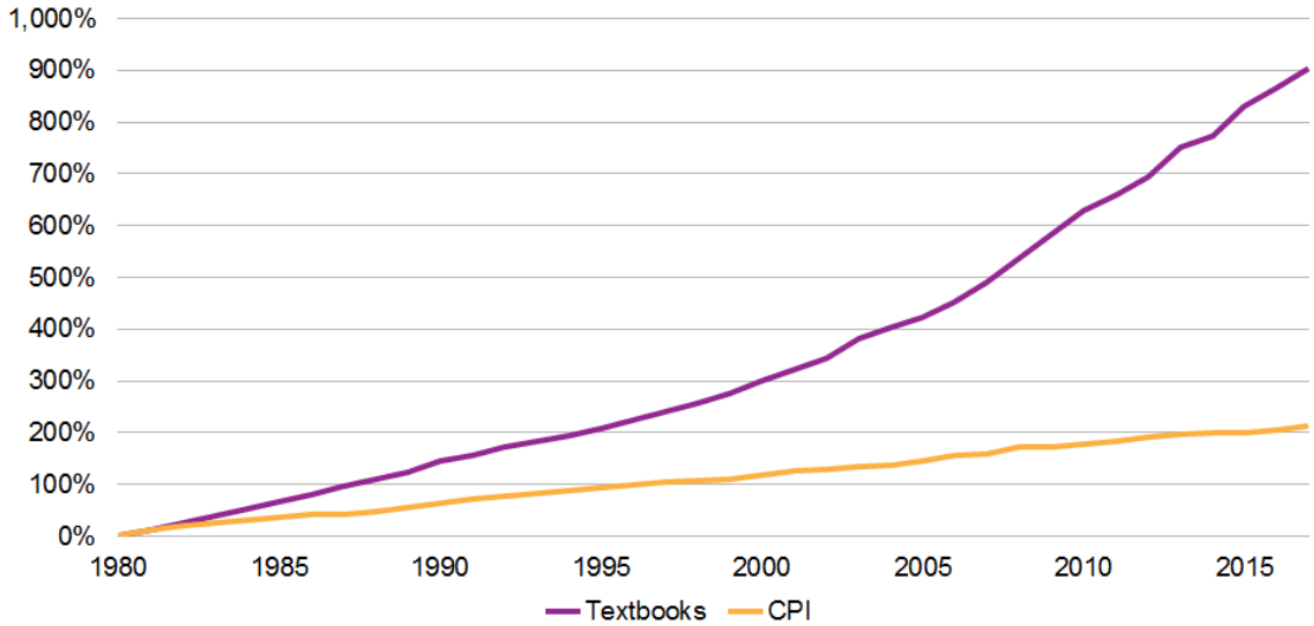
Result of a short visit to `Amazon.com` (which is usually significantly cheaper than our campus bookstore) to price just a few of those books:



Yes, Milton, Markets Can Fail 4

Rather than the usual capitalist feedback between buyer and seller, for textbooks the buyer [a student] is different from the decider [the professor]. Indeed, the decider [professor] is given not only free units, but also is bribed by the seller with many other goodies [test banks, homework solution books, PowerPoint decks for classroom use, *etc.*]. And so...

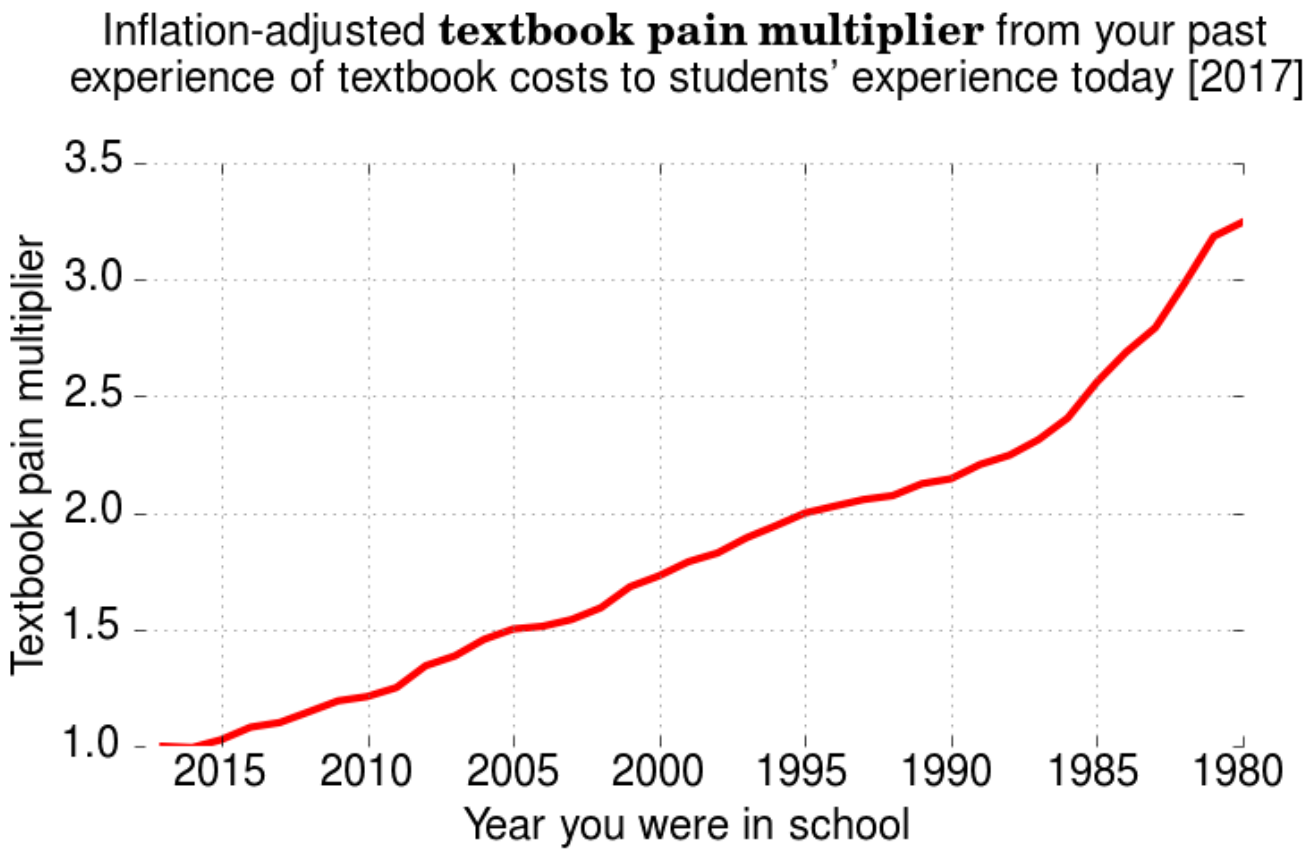
Increase in textbook costs since 1980



Source: *U.S. Bureau of Labor Statistics*

Your Intuition for Textbook Costs is Wrong

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



Source: https://mathematikoi.net/

Student Debt for Some Colorado Institutions

The easiest single indicator of exploding prices for students is:

total student debt in the U.S. is around $1.64 trillion.[6]

Some examples in Colorado:

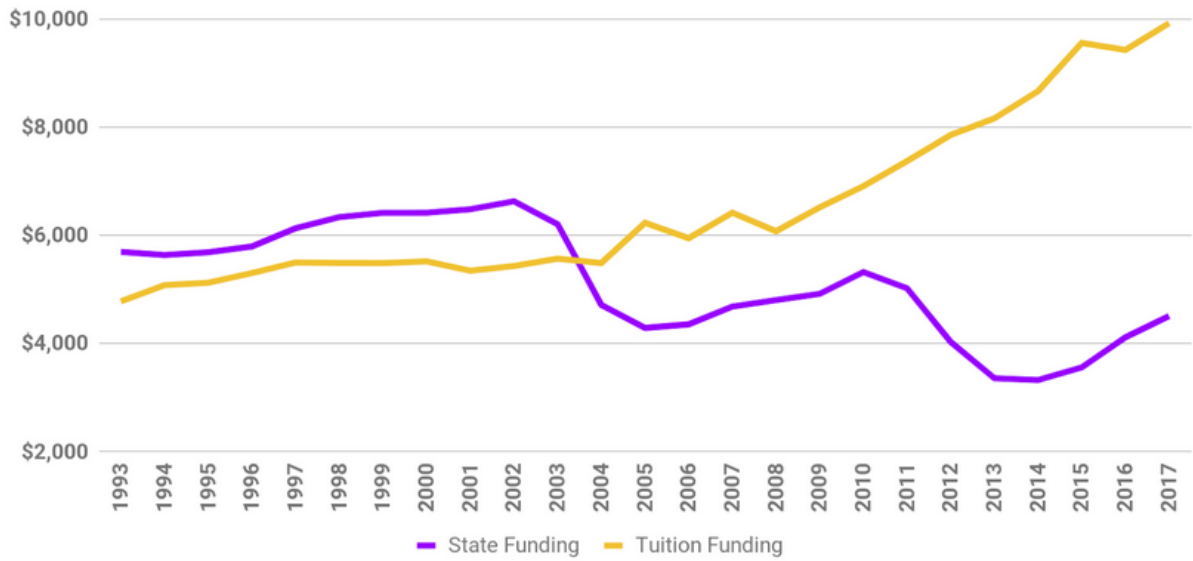
Institution	Median Debt, 2015 Grads
CSU Pueblo	$29,914
Front Range Community College	$13,500
Colorado College	$19,756
University of Denver	$29,050
All private[non-profit] and public 4-years in CO	$25,064
Aggregate Colorado Community College System	$11,730

Sources: https://ticas.org/posd/state-state-data-2015# and https://www.communitycollegereview.com/

[6] Source: https://www.federalreserve.gov/releases/g19/current/default.htm

Side remark: It's not just a market failure

Funding Sources For Higher Education In Colorado[7]



So, there is no real **public** higher education in Colorado.

Nor in a majority of the other states in the U.S.

[7] State Higher Education Executive Officers Association, https://www.sheeo.org

Food and Housing Insecurity Among Students in the US

The #RealCollege Survey found[8] in 2019 that for students in higher education in the United States

- 39% were food insecure in the 30 days before taking the survey,
- 46% were housing insecure in the last year, and
- 17% were homeless at some point in that year.

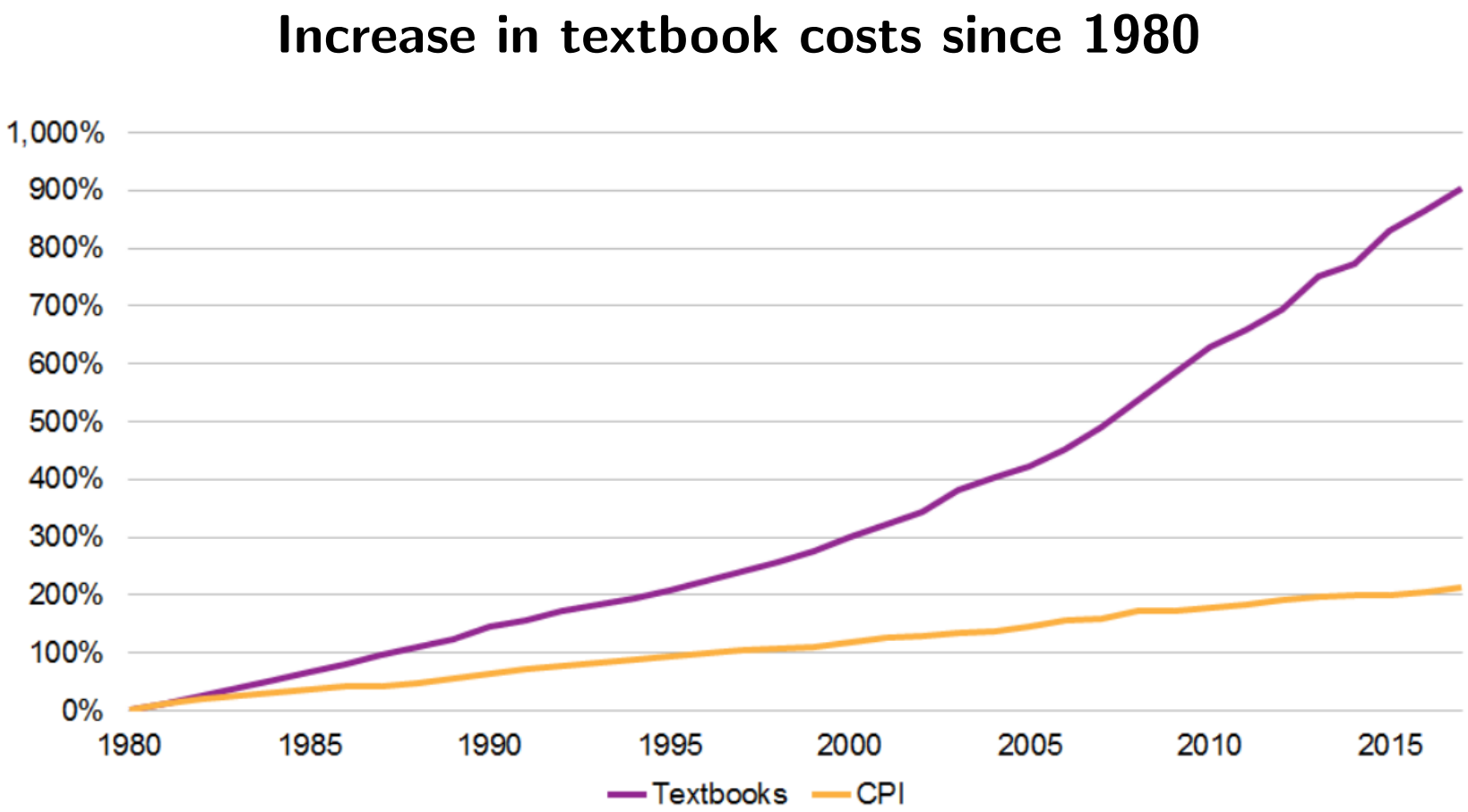
Now ask yourself: if you were a student in debt, [sometimes or often] hungry, and concerned about keeping a roof over your head ... where would your economic priorities be?

This is all very depressing... but maybe mass production has reduced costs, so shouldn't textbooks be nearly free?

[8] *#RealCollege 2020: Five Years of Evidence on campus Basic Needs Insecurity*, Baker-Smith, Coca, Goldrick-Rab, Looker, Richardson, Wilson, 2020, on the web here.

Textbook Costs 1

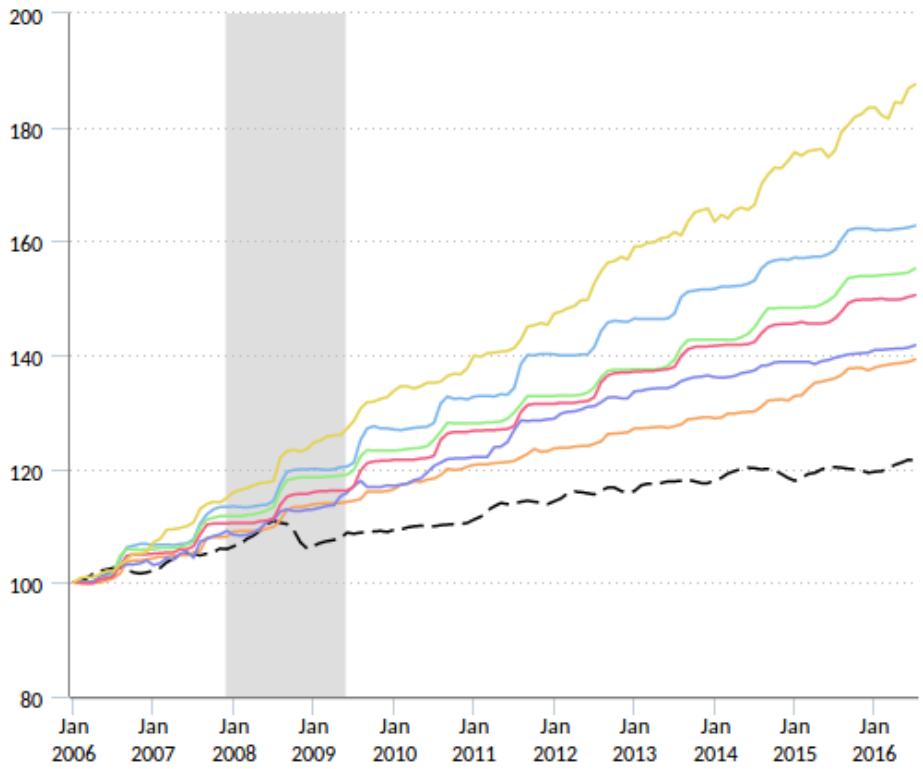
We saw this graph before:



Source: *U.S. Bureau of Labor Statistics*

Textbook Costs 2

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



January 2006 = 100

Source: *U.S. Bureau of Labor Statistics*

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

Consequences for Students

Studies[9] 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 study[10] 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**.

[9] 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.

[10] *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.

Conclusion of These Economic Issues

In summary:

- Grim, soulless neoliberalism has turned higher education from a public to a private good, resulting in a sky-rocketing cost to students.
- Students are in debt, and many are hungry and not confident in their housing situation.
- Textbooks costs are rising **much faster** than essentially all other consumer goods, because of a broken feedback loop in this market.
- As a result, students are learning less, doing less well, dropping out more, and taking longer to finish degrees.
- Switching to OER has large, immediate gains for student success, particular among underrepresented groups.

Wait, what was that term "OER?"

The acronym "OER" stands for **Open Educational Resources**.
In context above, it seems mostly to mean "free textbooks," but for that same low price you get even more:

> *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.*
>
> William and Flora Hewlett Foundation

Only OER truly respect an instructor's academic freedom!

What is academic freedom, and [why] do we deserve it?

Institutions of higher education are conducted for the common good and not to further the interest of either the individual teacher or the institution as a whole. The common good depends upon the free search for truth and its free exposition.

Academic freedom is essential to these purposes and applies to both teaching and research. Freedom in research is fundamental to the advancement of truth. Academic freedom in its teaching aspect is fundamental for the protection of the rights of the teacher in teaching and of the student to freedom in learning.

emphasis added
American Association of University Professors
1940 Statement of Principles on Academic Freedom and Tenure

That word "common" – how wide a net do we cast?



The UN has a very expansive view of what the *common good* is, including[11] the idea that *"...higher education shall be equally accessible to all..."*



The US recognizes[12] physical and mental disabilities to be *handicaps*; at CSUP we must say in our syllabi that *'...no student shall be denied the benefits of an education 'solely by reason of a handicap'..."*

Note that the ADA doesn't say "17% of students may be denied the benefits of an education" or even 10% or 1% – it is "**no student**"!
Question: Do you think a student is more responsible for their financial situation than for "handicaps?" What percentage of students are **you** willing to deny the benefits of education based on financial difficulties?

[11] in Article 26 of the *Universal Declaration of Human Rights*
[12] in the Americans with Disabilities Act of 1990

Freedom includes the right to be an ass, or a saint

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 in the hope of writing the next bestseller on the history of refrigeration, 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*.

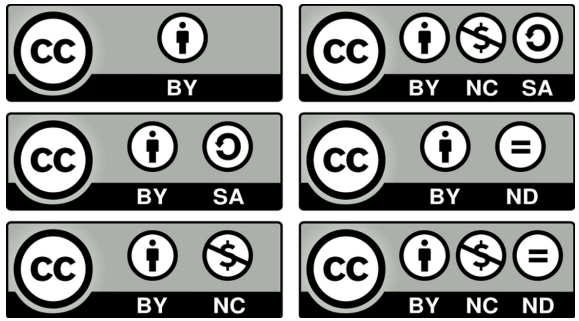
If there were a way to dedicate a creative work to this commons, rather than having it automatically fall into the domain of *all rights reserved* copyrights[13], many scholars [and, more widely, artists] would likely do so.

The way to do this is with Creative Commons Licenses.

[13] Which I like to think of as *the Land of Mordor, where the Shadows lie*.

Creative commons licenses

The way to bend copyright law to the purposes of the scholarly [and artistic] life is to release works with a Creative Commons Licenses:[14]



Educational resources released with a CC license – well, **not** those two licenses with "ND" – are open to repurposing by others, allowing faculty to build bespoke resources that fit perfectly their class, and their ideas for how to teach it. Which ideas we must respect because **academic freedom**.

Take the Creative Commons Certificate Course – I did, it's incredibly useful and fun! So much fun, in fact, that now I teach it!

[14] see https://creativecommons.org or my Creative Commons Cheat Sheet for University Faculty

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

LaTeXwas FLOSS even before the Internet was a twinkle in Al Gore's eye.

Today, we mostly share 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 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 or the page for this slide deck.

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 LaTeX).

There is also a tool called **PreTeXt** (see https://pretextbook.org/) which is probably better – 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 and colleagues at Red Rocks Community College have done some amazing things with it – talk to her (or watch a wonderful webinar which the CO OER Council[15] sponsored (and recorded, here).

[15] an entity created by Colorado's HB18-1331 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

- \$1.64**trillion** in student debt
- 17% 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 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 an OER committee on your campus
- use an OER textbook in a class – start with one from OpenStax or The Open Textbook Library, that's probably easiest
- talk to your librarian colleagues (they have super-powers)
- go to OER conferences ($\exists$ many such, such as the Colorado OER Conference and the Open Ed 2020 conference, which will probably be in Colorado), pandemics permitting.
- apply for OER grants ($\exists$ many such, such as from the state of Colorado and the U.S. Department of Education)
- Coloradans should keep and eye on this site for other announcements

Questions, comments? Contact. Getting slides [links!]

Questions? Comments?

Email (feel free!): jonathan@poritz.net ; Tweety-bird: @poritzj .

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[16] subject to CC-BY-SA