EDITORIAL
Open Educational Resources for Undergraduate Neuroscience Education

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This editorial discusses the impact of Open Educational Resources (OER) on the success of undergraduate neuroscience students. In order to provide students with high-quality, accessible, free educational materials, we have launched a series of free neuroscience textbooks and ancillary materials. These are a work in progress and would benefit from contributions from the FUN community.

Textbook expenses disproportionately impact first-generation students, students of color, and those on financial aid, often preventing timely access to materials, increasing stress, and hindering academic success. The research suggests that traditional textbooks fail to meet students' needs, either because they are unnecessary or financially burdensome. Free, high-quality neuroscience OER textbooks can alleviate financial stress, lower DFW (drop, fail, withdraw) rates, and improve student-teacher relationships, ultimately enhancing the learning experience. By reducing barriers, OER can foster equitable access to education and support student success in neuroscience and beyond.

Key words: first-generation students; open educational resources; textbook costs; social justice; STEM education; students of color

OPEN EDUCATIONAL RESOURCES AS A SOCIAL JUSTICE ISSUE

It is our belief that neuroscience is an "Ur-STEM" field. Students learning neuroscience at the undergraduate level must know at least a modicum of information about physics, chemistry, biology, instrumentation, engineering models of neural systems, computer science, and mathematics.

Despite the importance of understanding neuroscience, most faculty require students to make significant financial sacrifices to purchase required textbooks. In a time when faculty are being judged by the rate of D or F grades and withdrawals (i.e. the "DFW rate"), the cost of textbooks increases the DFW rate. More than half of students report that they did not purchase the "required" textbook in at least one college class. About one-quarter of students dropped at least one college course because they perceived they could not afford the textbook.

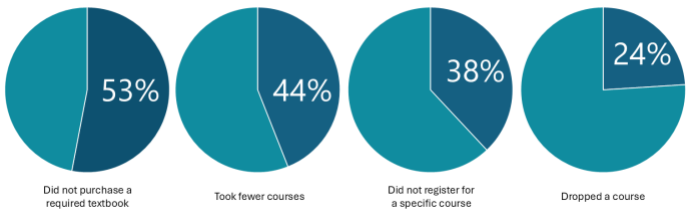

Figure 1. Students set themselves up for failure by not purchasing textbooks (Florida Virtual Campus, 2024). Numbers represent percentage of Florida college students who answered that they had engaged in the described behavior surrounding textbooks. (Because students could choose more than one option, the total is more than 100%.)

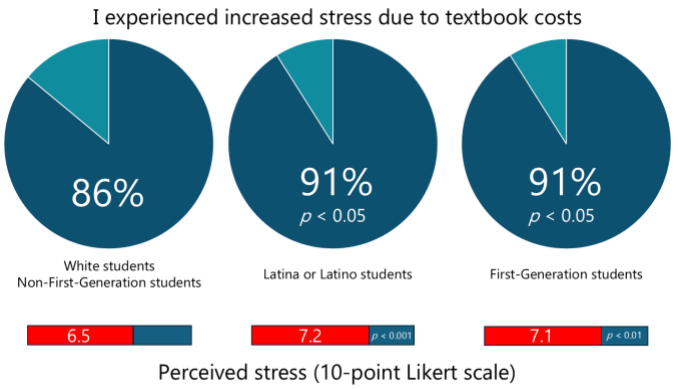

Figure 2. Students' perceived stress due to textbook costs. Data from Jenkins *et al.* (2020) CC BY.

Jenkins *et al.* (2020) report that 1 in 8 students have dropped a class, and 1 in 11 students have failed a class, due to textbook costs (Figure 2). We know intuitively, and from our experience as faculty, that students struggle with neuroscience classes. We set a significant proportion of our students on a path to failure when we require expensive textbooks. Students whose family background is Spanish speaking are disproportionately affected by textbook costs. The failure rate (attributed to textbook cost) for these students is almost three times that of the failure rate for non-Hispanic White students.

At Weber State University, about 1/3 of our students are the first in their families to attend college (i.e. "first-generation students"). Stress levels and failure metrics, attributable to textbook costs, are similarly high amongst this student population.

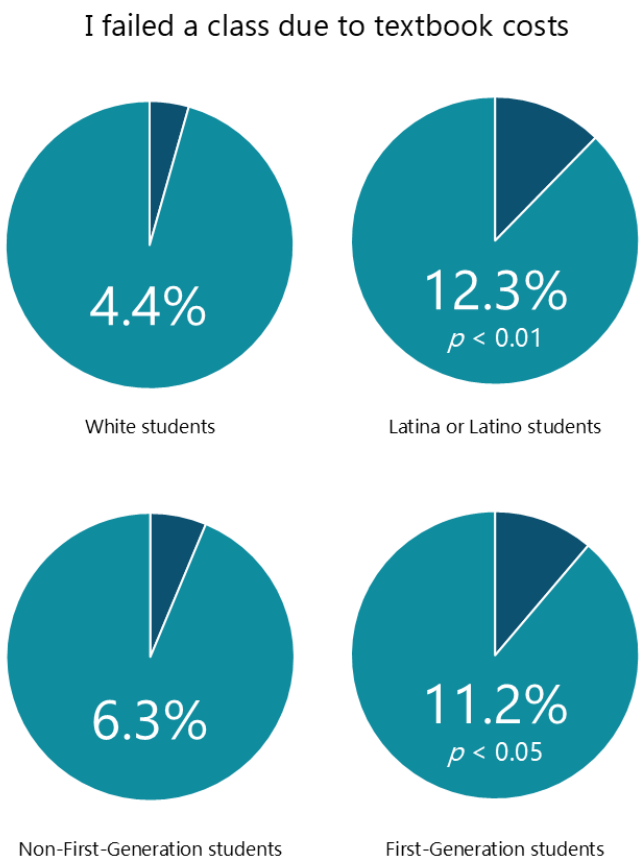

Figure 3. Students' self-report on failing classes due to textbook costs. Data from Jenkins *et al*. (2020) CC BY.

We know students (and probably most faculty) suffer under the burden of "imposter syndrome". It is our hypothesis that textbook costs contribute to this burden by reinforcing the students' perception that they must not belong in college because they can't afford the study materials.

We can reduce the textbook costs of our courses to zero by using open educational resources (OER). This has the potential to reduce stress and help our students be successful in these courses which are critical for an understanding of all STEM fields.

EXISTING OPEN EDUCATIONAL RESOURCE MATERIALS IN NEUROSCIENCE

A number of other open-source, free neuroscience textbooks are currently available. Melanie Leussis provided a review of the OER neuroscience resources as of 2022; the reader is referred to that list and we have noted only changes since then in the resources listed below.

Valerie Hedges at Michigan State University (MSU) has created an OER textbook of neuroscience to support the two-semester sequence Introduction to Neuroscience I and II. https://openbooks.lib.msu.edu/introneuroscience1/ However, by design, it only contains those topics included in the MSU courses and does not offer prospective OER adapters or adopters a selection of content. It is our hope to offer about three to five times as many chapters in our in-progress Introduction to Neuroscience (see below) so that potential faculty adapters can select the chapters that best fit their needs. For example, we believe it would be ideal to eventually offer three levels of presentation for a single system such as visual system, so that faculty could choose the level that best meets the needs of their students or could even, in some cases, make an entire specialty course (such as perception) out of chapters from the four books listed below. This depends critically on our ability to recruit FUN members to author textbook chapters in their areas of expertise.

Elizabeth Kirby and collaborators Melissa Glenn, Noah Sandstrom, and Christina Williams have created an OER textbook published by OpenStax, *Introduction to Behavioral Neuroscience*. It is a relatively recent release, with an inception date of November, 2024. https://openstax.org/details/books/introduction-behavioral-neuroscience

One strength of *Introduction to Behavioral Neuroscience* is the large number of authors represented, and its focus on supporting any sort of behavioral neuroscience class. The illustrations are extremely high-quality, and the writing is authoritative and complete. Still, while topics like neurophysiology and neurochemistry are represented here, the coverage is necessarily less in-depth than many programs require for an Introduction to Neuroscience course or Cellular and Molecular Neuroscience course, since the aim is to teach the student what they need to prepare for an understanding of behavioral neuroscience topics.

IN-PROGRESS TEXTBOOKS

We are not suggesting that the textbooks listed below, published on the PressBooks platform, are "done". Rather, we hope to provide a large group of reservoirs of neuroscience information which all undergraduate neuroscience faculty can draw from. Faculty can incorporate any or all of these materials in their courses without charge. They can use these materials as reading assignments, handouts, or even select specific chapters to create a custom-built textbook of neuroscience in support of a semester course in neuroscience.

It is our hope that our educational community who read this, or their students, will help by contributing chapters in their area of interest to help fill out the stable of resources we've begun to develop. Our intention is to "prime the pump" rather than claim a completed textbook in the conventional sense. The nature of OER materials is that these are continually growing and changing resources, a sort of curated wiki of neuroscience covering all levels of undergraduate learning.

Introduction to Neuroscience

https://uen.pressbooks.pub/introneuro/

Our Introduction to Neuroscience class has traditionally included three components. First, we start with an introduction to neuroanatomy, cell and molecular biology, neurophysiology, and synaptic physiology. Second, we turn our attention to systems neuroscience. In this section, we present one of the sensory systems (typically the visual system) and the motor systems. Finally, we pick one

specialized function of the nervous system, typically sex and the brain, language, or addiction.

These sections are mostly built out so we can use this text in support of our Introduction to Neuroscience classes. We have outlined all the sensory systems but have not yet written these sections. Tom Finger has generously contributed material on invertebrate olfaction, and we will incorporate more sections such as this as they are given to us.

Developing Expertise in Neuroscience
https://uen.pressbooks.pub/expertneuro/
For this book, we have adopted a different approach to building the material. Students in Hutchins' Cellular and Molecular Neuroscience class have each contributed three chapters in the five general topic areas of Neurons as Cells, The Neuronal Membrane, The Synapse, The Modifiable Synapse, and Development of the Nervous System.

Other faculty's experiences may be different, but we found it impossible to find any textbook written at an appropriate level to use as a basis for the Cellular and Molecular Neuroscience class. Students struggled to understand the peer-reviewed literature without scaffolding from an intermediate-level textbook. Hutchins has been teaching this class annually for seven years, so had a good set of PowerPoint slides on which to build this textbook.

As a bridge between the introductory and advanced textbooks, this book will likely be expanded by FUN member contributions. There are many topic areas yet to be explored at the college junior or senior level which are not yet a part of this book.

Advanced Neuroscience
https://uen.pressbooks.pub/advneuro/
Material supporting Weber State's Clinical Neuroscience course initially formed the basis for this book, but Kobe Christensen, a student graduate of the University of Utah's program in Electroneurodiagnostics (END), has also contributed his teaching materials for END students as a large section of this book. The University of Utah END Institute offers a certificate program preparing students for clinical work interpreting EEG data in settings such as the pediatric epilepsy clinic, intraoperative monitoring, or sleep labs.

Another section of this book grew from a talk Hutchins gave to math majors on quantitative analysis in neuroscience. Cody Zundel, a student in the College of Science at Weber State, agreed to write up many of the topics covered in Hutchins' lecture, including the Equivalent Circuit Model of the Cell Membrane, Cable Theory, and the derivation of the Nernst-Planck Equation from Fick's First Law and Einstein's Drift Equation. Chapters which are too heavy on mathematical analysis for the average neuroscience undergraduate are located here, where they can be used as reference material for students who have the mathematical skills to understand these advanced topics.

Human Neuroanatomy
https://uen.pressbooks.pub/neuroanatomy/
As we began to incorporate neuroanatomy teaching materials into *Advanced Neuroscience*, we identified a strong demand for slightly different versions of these topics in our Physician Assistant program, the END Institute students, and our home-grown Human Neuroanatomy course.

Accordingly, we created a fourth textbook which is outside the three-tier system of Intro/Developing Expertise/Advanced textbooks and called it *Human Neuroanatomy*. An innovation of this book will be simplified diagrams of single structures rather than the currently available images which have dozens of leader lines on a single piece of base art. We are in the process of validating this teaching approach with outcomes research and will use whichever neuroanatomy teaching approach proves to be the most effective in these studies.

ANCILLARY MATERIALS

One strong incentive for junior faculty to adopt legacy textbooks is the availability of ancillary materials: PowerPoints, exam questions, and formative learning activities. It is our intention to provide these materials as well.

Our resource has these materials for the Introduction to Neuroscience book chapters used in the Weber State course. As more community members adopt parts of the "textbook" project, we hope to incorporate their contributions to the overall project so that all may benefit from the availability of these resources.

As described in the next section, it is likely that these resources will become the main "draw" of the project as it matures and grows.

THE FUTURE OF TEXTBOOKS

There is serious doubt that the textbook as codex (i.e. printed pages in a binding) will exist much further into the 21st century. Technology is moving quickly, and the codex seems to be a dying format.

Why, then, do we advocate for OER textbooks of neuroscience? Because neuroscience faculty must seize the means of production and develop the capacity to freely share our knowledge with our students without a corporate intermediary. As long as the profit motive is interposed between student and learner, there will be students who are disproportionately harmed by the need to justify the corporate bottom line.

If we truly believe that a neuroscience education is an engine of social mobility — and the authors believe this strongly — then reducing the costs of learning materials is part of the academy's responsibility to a just society. The four cornerstones of medical ethics are autonomy, beneficence, non-maleficence, and justice. We believe the four cornerstones of ethical teaching should match these.

OER learning materials provide autonomy to our students. Open Educational Resources necessarily drive open pedagogy (BCcampus Open Education, 2013). Open pedagogy is an approach which measurably increases student autonomy.

OER learning materials can be beneficial to students. By capturing best practices from across the FUN community, working together we can provide the best possible learning opportunities for our students by giving faculty a menu of high-quality options to choose from.

Textbook costs harm student learning and student self-confidence (Jenkins *et al*. 2020). By reducing the costs of learning materials to zero, we provide a non-maleficent solution to the harmful profit-based domination of our students, especially those wanting to elevate their social standing through education.

Finally, OER materials promote justice. They provide needed resources to all our students, not only those whose families can afford them.

We look forward to hearing from other neuroscience community members who are interested in contributing to the construction of this powerful engine for neuroscience education.

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