

skin cancer because we cannot know whether the increased rate of skin cancer was due to the use of sunscreen, sun exposure, or some other unknown confounding variable.

Recognizing confounding variables in observational studies takes practice, and this skill, I would argue, is the most valuable skill a student should gain from an introductory statistics course. Traditionally, this course did not go beyond two variables. The curriculum would start with one categorical variable, then one quantitative variable, then move to a difference in proportions, a difference in means, and finally, regression. The modern introductory statistics course, however, engages students with multivariable data sets from the beginning, exploring relationships between multiple variables through data visualization.

Getting Started in the Classroom

The two best pieces of advice that I was given as a new teacher of statistics were: (1) start small, and (2) use existing materials. Like myself, you may be used to the lecture-style classroom, and the thought of fostering active learning may seem uncomfortable and overwhelming. Start with introducing an activity into a single class. Try it out. See how it goes. Slowly, you can begin introducing more activities, adapting course materials to your own teaching style, and eventually, you will build a statistics course which exemplifies the GAISE recommendations.

When looking for existing materials, the GAISE College Report is an excellent place to start. Indeed, the six GAISE recommendations can apply to any statistics course, not just at the introductory level, and the report contains a vast number of classroom activities, projects, data sets, and assessment items. The Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) website, <https://www.causeweb.org>, has a collection of resources for the undergraduate statistics education community from syllabi and cartoons to discussions and suggestions on how to teach simulation-based inference. When you read an interesting news article on a recent study, bookmark the article and save the bookmarks in a folder of potential case studies for your course. I also highly recommend checking out Allan Rossman's *Ask Good Questions* blog [All19].

I'll conclude with one last quote, by the American writer Alice Wellington Rollins:

The test of a good teacher is not how many questions he can ask his pupils that they will answer readily, but how many questions he inspires them to ask him which he finds it hard to answer. [Ali98, p. 339]

This quote appeared in the *Journal of Education* in 1898, yet it continues to be relevant today. In asking our students good questions, our ultimate goal is to transfer that skill to our students.

References

- [Ali98] Alice Wellington Rollins, *What they say*, The Journal of Education 47 (1898), no. 22 (1181), 339–339.
- [All19] Allan Rossman, *Ask good questions*, 2019.
- [Cla17] Claire Cain Miller, *The gender pay gap is largely because of motherhood*, The New York Times (May 13, 2017).
- [Gab03] Gaby Hinsliff, *Diet of fish 'can prevent' teen violence*, The Guardian (September 14, 2003).
- [GAI16] GAISE College Report ASA Revision Committee, *Guidelines for assessment and instruction in statistics education college report 2016*, 2016.
- [Joh15] John Bohannon, *I fooled millions into thinking chocolate helps weight loss. Here's how*, Gizmodo (May 27, 2015).
- [Kah11] Daniel Kahneman, *Thinking, fast and slow*, Farrar, Straus and Giroux, New York, 2011.
- [Lau18] Laura Mitchell, *Eating chocolate can help you LOSE weight, shock study discovers*, The Daily Star (July 7, 2018).
- [The06] The Canadian Press, *Music lessons improve kids' brain development, memory: study*, CBC Radio-Canada (September 20, 2006).



Stacey Hancock

Credits

Author photo is courtesy of Stacey Hancock.

Contributing to Open Education: Why, How, and What I am Doing

Mine Dogucu

My social media timeline has reminded me that five years ago I was reading Bolstad's *Introduction to Bayesian Statistics* [Bol07]. I was a graduate student back then. Now I am a professor teaching statistics and data science. I am currently

Mine Dogucu is an assistant professor of teaching in the department of statistics at the University of California Irvine. Her email address is mdogucu@uci.edu.

DOI: <https://dx.doi.org/10.1090/noti2232>

cowriting the book *Bayes Rules! An Introduction to Bayesian Modeling with R* [JOD21] that is open access.¹ I share my teaching materials on my course websites (e.g., <https://www.introdata.science>) and keep a blog on teaching data science. Five years ago, if someone had told me that my teaching materials would be accessible to the public on the internet, I would not have believed them as I knew very little about open education. Today my personal rule is that if I have any teaching materials sitting on my computer that could potentially benefit others, I should make them publicly available. My way of contributing to open education is sharing my teaching materials in the public domain. I will share my experiences from the last five years on how I embraced open education, started to contribute to it, the tools and resources I use, and why I would recommend it, especially to early-career instructors.

Why Open Education?

My interest in open education first started with using open access books in my courses. I have mostly taught at public institutions and found textbooks, supplemental websites, and other educational materials to be unaffordable for my students. Early on I decided to assign my students open access books (e.g., OpenIntro Statistics, a collection of open access introductory statistics books) or assign them books that are accessible electronically through the school library when possible.

Beyond textbooks, I came across numerous faculty websites with teaching materials from their courses. Have you ever taught a course for the first time and a colleague gave you all their teaching materials from the time that they taught the course? The first time anyone teaches a course they may want to know how everyone else is teaching the same course, how others are ordering the topics, and what resources others are using. We may not necessarily use their materials but even knowing what they are doing can help us shape our ideas. Finding faculty websites with course materials in the public domain was beneficial for me to develop my own. Having benefited from open work of others I decided to share my work openly as well.

Open education contributions, whether it is course websites, blogs, or books, not only help learners. Sharing our teaching in the public domain can help us treat teaching as a collective action, moving us all forward together. We can learn from each other's examples, illustrations, jokes, and analogies. We can use them, reuse them, and improve them.

Getting Out of your Comfort Zone

When we talk about doing anything out in the public as teachers or scholars, whether it is open science or open education, we often talk about the tools we need and the best practices. Even when I knew the tools and the best practices I could not get myself to share teaching materials

¹(Dogucu) The first five chapters of the book are available at <https://www.bayesrulesbook.com>.

publicly. As scholars, we are expected to share our work with the public. However, doing this early in my career was a lot harder.

What has helped me get out of my comfort zone was finding a community that appreciated my work and used my work that I shared publicly. In my case, this supportive network was R Ladies, a global organization that supports gender minorities in the R community. When I gave a talk on missing data to the R Ladies New York chapter right after finishing my PhD, it was the first time I shared everything related to my talk: the data, the code, and the presentation. A few months later, a community member messaged me asking me to remind her of the link for the materials because this was the best missing data resource for them. I wrote my PhD dissertation on missing data and I know that my slides were not necessarily the best resource on the topic but this correspondence made me realize that many missing data resources are behind a paywall and considering the way I introduced the topic, my talk might be a useful resource for this person.

An instructor does not necessarily have to share all of their teaching materials with the public. It is not a dichotomy of whether one embraces open education or not. Sharing a single figure may help other learners and instructors. For instance, Allison Horst generously shares her illustrations in the public domain such as the one in Figure 1. I have used her illustrations in my teaching multiple times.

For any readers who are trying to find the courage to get out of their comfort zone, I would suggest that you start taking one small step at a time, find a supportive community, and focus on the impact you would be making.

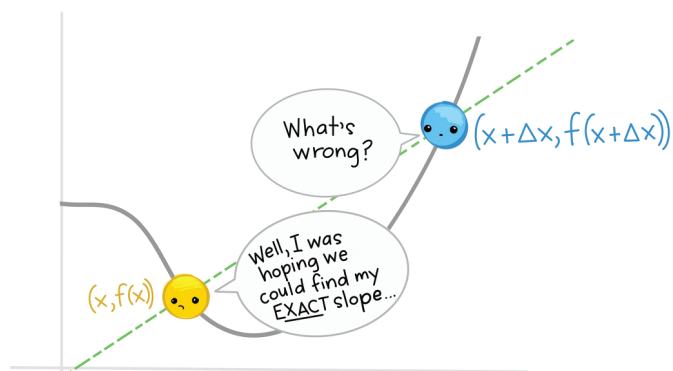


Figure 1. Derivative 5 by Allison Horst is licensed under CC BY 4.0.

Tools and Resources

I find having a single environment for all my work helps keep my work flow organized. For me, this environment is R Markdown [XAG18] and I understand that for many readers this may be LaTeX. I use R Markdown to create my course materials (presentations, handouts, exams, etc.), write my journal articles, run data analyses, build websites, write a book, and keep a blog. In the past, I used to do most of my work in a LaTeX environment; however, over the years

I switched to R Markdown mainly because I teach R Markdown in my courses and I wanted the tools I use and the tools I teach to be consistent. I can teach R Markdown even in my introductory-level classes. I should also note that I do write LaTeX equations and use LaTeX templates within R Markdown when needed so I have not given up LaTeX.

As I started contributing to open education, I had to learn about copyright and licenses. Learning about licenses has also helped me understand what I can and cannot use from others' resources. I would suggest you check what I report here with a lawyer if needed as anything I provide is not legal advice. For my work, I use Creative Commons licenses. Depending on the work, if needed I put some limitations on how the work is shared publicly. I sometimes use the share-alike license which requires that if someone uses or edits the work, they must share it with the same license. I often use the noncommercial license which prevents commercial use of my work. One can also use a combination of these licenses. For instance, our aforementioned Bayesian book is shared with Creative Commons Attribution-NonCommercial-No Derivatives 4.0 International License.²

Sharing my teaching beyond my classroom has made me more considerate of accessibility, a topic that I am still learning about. I started using screen readers to test whether my materials are readable by screen readers. A screen reader reads what is on the screen out loud. This is important technology for the visually impaired. Using a screen reader has made me aware of writing alternate text for images so that the alternate text of the image can be read by screen readers. I also started using colors from the Okabe and Ito color-palette to make figures that are friendly to colorblind people [OI02]. I still have to learn a lot about accessibility.

I also found social media to be a beneficial resource in finding open education resources and disseminating my work, as well as meeting other statisticians and data science educators. I connected with many people from around the world on Twitter. For instance, I met one of my coauthors on Twitter and this connection has resulted in coauthorship of our Bayesian book.

What Is in it for the Instructor?

Sharing my teaching openly has benefited me as well. In academia the impact of someone's work is usually measured by the number of publications and citations. Contributing to open education has taught me that I can define my own impact of my work which helps with my well-being regardless of how academia measures my impact. My websites have been visited by thousands of people from more than 100 countries. I do not think I would have reached the same number of people with only journal publications as a junior faculty. I do not think even physical copies of our book when published would make it to 100 countries.

²(Dogucu)<https://creativecommons.org/licenses/by-nc-nd/4.0/>

More importantly, if all my teaching materials were sitting on my computer it would have only helped my students.

The internet provides a medium for us to publish work that does not necessarily fall under the traditional publication umbrella such as journal or book publication. For instance, I started my blog <https://www.DataPedagogy.com> over the summer with the intention that I would share my thoughts—longer than a tweet, shorter than a manuscript—on data, pedagogy, and data pedagogy. What I share on this blog would not have made it to the public otherwise. Even for more traditional publications such as books, one can publish a work in progress or update published books online which can make the online version of the book stay more current than the hard-copy book.

Sharing work publicly has also provided me with newer opportunities and introduced me to newer networks. Due to my blog, I was invited to write this piece for the *AMS Notices* and similarly a blog post I wrote is to be published in the American Statistical Association's *AMSTAT News*. This is my first connection ever to the AMS network and I feel fortunate about that. Through this connection, I even got to learn about one more collection of open education resources at *AMS Open Math Notes*.³

In the last five years I have changed as a teacher and a scholar in many ways. Open education has been a big part of this change. I have benefited from both using open education resources and contributing my own. I would recommend contributing to open education to anyone, especially to early-career professionals who are looking for ways to share their work and to connect with other educators.

References

- [Bol07] William M. Bolstad, *Introduction to Bayesian statistics*, 2nd ed., Wiley-Interscience [John Wiley & Sons], Hoboken, NJ, 2007. MR2352885
- [JOD21] Alicia A. Johnson, Miles Ott, and Mine Dogucu, *Bayes rules! An introduction to Bayesian modeling with R*, CRC Press, 2021, forthcoming.
- [OI02] Masataka Okabe and Kei Ito, *Color universal design (cud): How to make figures and presentations that are friendly to colorblind people*, <https://jfly.uni-koeln.de/color> [p 9] (2002).

[XAG18] Yihui Xie, Joseph J. Allaire, and Garrett Grolemund, *R markdown: The definitive guide*, CRC Press, 2018.



Mine Dogucu

Credits

Figure 1 is by Allison Horst and is licensed under CC BY 4.0. Author photo is courtesy of Mine Dogucu.

³(Dogucu)<https://www.ams.org/open-math-notes>