Framework for
Open and
Reproducible
Research Training

FORRT

FORRT syllabi: O&R 101

Open and Reproducible Science Syllabus

Background for Educators: In order to teach open and reproducible science effectively, educators need to make sense of almost a decade of literature, across several fields, and be informed about ongoing (and often dynamic) debates. This is a tall ask. FORRT sought to help scholars implement open and reproducible science tenets in their teaching and mentoring workflow and now, in an effort to reduce some of the burden on educators wishing to learn or teach these concepts, FORRT has drawn on the expertise of more than 50 experts from its community to provide educators with a comprehensive but straightforward accessible didactic framework. FORRT clusters is a result of a comprehensive literature review guided by *educational, pedagogical and didactic considerations.* FORRT hopes to provide a pathway towards the incremental adoption of Open and Reproducible Science tenets into teaching and mentoring. FORRT's focus lies not only on aggregating the literature into bins, but on making sense of existing works, weaving connections where none exist, and providing a sensible learning-oriented Open and Reproducible Science taxonomy. FORRT's Open and Reproducible taxonomy is composed of 7 clusters, which we represent as separate weeks in this course.

Using this document: We did not develop this syllabi to cement a single way to implement FORRT principles in your teaching. It is not intended to represent a one-size-fits-all approach to introducing students to openness and reproducibility. A wealth of approaches exist, including knitting open and reproducible research practices into subject specific courses. Many amazing instructors have developed their own syllabi teaching these concepts (https://osf.io/9v2sy/) and we urge you to take inspiration from their efforts. We developed this syllabi to provide an example of how teachers can draw resources from FORRTs educational NEXUS to develop a syllabi to fit their needs.

We developed this syllabi with virtual learning in mind. It is set up as a seminar series covering 9 weeks and a variety of activities during those weeks.

O&R 101:

Open and Reproducible Science Syllabus

Class meetings: Wednesdays 12:00 – 13:50 in 257 Straub

Office hours: Held on Twitter at your convenience (@FORRTproject)

Course description:

How can we increase the credibility of research? We will come back to this question frequently during this seminar series. In O&R 101 we engage with a number of research practices that aim to increase the transparency and reproducibility of your research. The learning objectives, and what you will be graded on, is developing our thinking about how these practices can be integrated with current research practices - and maybe your next study.

In this virtual era, we will be mixing asymmetric and symmetric classes. Each week there will be a 20-30 minute video lecture on the topic (except week 9). Then, at [insert office time here] we will meet virtually to discuss the reading material.

Course materials:

Most of the course materials can be accessed via the FORRT resources page. Many of the further readings are summarised at the FORRT summaries page. If you are interested in Open and Reproducible Science and feel like chatting with members of the community, join us at the monthly FORRT's Open Office Hours. If you would like to write a BA or MA on the topic, please visit FORRT's Remote Mentorship program where we help (a) students from underprivileged and underrepresented backgrounds; (b) non-WEIRD; and (c) students from departments when there is no local OS-friendly institutions or personnel to find a thesis supervisor. Importantly, if you are from an underprivileged or underrepresented early-career researcher, please subscribe to the Support for underprivileged and underrepresented early-career researchers program whose goal is to chip away at the barriers that exist and to promote a more inclusive environment for all in academia. If you cannot access any of the materials, please speak to the course leader who can provide you with a copy. We cannot advise to use https://sci-hub.se/, which provides free access to over 80 million research papers, or http://libgen.rs/ or https://b-ok.cc/, which provide additional millions of educational books and encyclopedias because pirating is naughty.

Assignments and Grading:

We have included a range of assessed activities to ensure that participants gain the most from the course

Participation (20%): The focus of the seminar is discussion, so how well and how deeply you interact with the material and productively interact during the discussions is important.

Maximum marks are given for demonstrating good preparation for each seminar, insightful analysis of the readings, good evaluation of the applicability of each research practice to different research areas, and active involvement. Note that we value good classroom citizenship, including respecting others opinions, being inclusive, not dominating the discussion, and being respectful of others (with thanks to Professor Strand for showcasing this concept in her syllabi).

Written Assignments (30%): Each week you will select an article relating to that week's topic (not the suggested readings - see the FORRT resources page for inspiration) and write a short description following the format of the FORRT summaries. There are around 130 of these summaries on the website, the papers included are off limits for this assignment, for obvious reasons. These summaries should be short and easy for others to digest. You will compile and submit these summaries at the end of the course, but we highly recommend using this exercise as preparation for the class discussion.

There is a bonus mark available for giving FORRT permission to use your summaries on the website.

Group assignments / presentation (20%): In groups of 4 you will propose an interesting way to teach one of the concepts covered in previous weeks. The target audience could be undergraduates, but it could also be graduate students, or even super-senior professors! You could propose a full course, or a single 10 minute lesson based on a specific tool or case. All rules are off, but maximum marks will be given for novelty and how engaging the teaching format will be for students (we like interactive). It will be important to think carefully about your audience, and the tools that you're thinking of using. If it's a course you'd find dull, then others will too.

Your presentations should be no longer than 20 minutes with 10 minutes for questions from the class. Contributions to the presentation and to answering questions should be equal across the group.

Groups will be decided in week 1. In week 4 we will dedicate time during the class to discuss the assignment and questions you have.

Term paper (30%): "What are the strengths and limitations of including this O&R practice in my research project?" (2000-3000 words)

You will pick one of the open and reproducible research practices discussed in this course. Your task is to reflect on this research practice with your next research project in mind (maybe for a lab you are working as a RA in, or your final year research project). Specifically, how would enacting that practice influence the project? What aspects would the practice help? What difficulties do you foresee in using this practice?

The key to this paper (and maximum marks) is to reflect deeply on what the specific practice means for your research process. It is not enough to say "it will be better research, but it will take longer". We need to understand the trade off between using the practice and not using it.

Homework (ungraded): Your post-course homework, should you choose to accept it, is to try to include one of the open and reproducible research practices we discuss in this course in your next project. Ideally, one that you weren't already guaranteed to do. Then, email the course leader with news of your success!

Schedule:

Week 1. Reproducibility and replicability knowledge

Core readings:

> Munafo, M. R., et al. (2017). A manifesto for reproducible science. *Nature Human Behaviour, 1*, 0021. DOI: 10.0138/s41562-016-0021
>
> Gelman, A., & Loken, E. (2013). The garden of forking paths: Why multiple comparisons can be a problem, even when there is no "fishing expedition" or "p-hacking" and the research hypothesis was posited ahead of time. *Unpublished manuscript.* http://www.stat.columbia.edu/~gelman/research/unpublished/p_hacking.pdf

Additional readings:

> Baker, M. (2016). Is there a reproducibility crisis? *Nature, 533*(7604), 3–5. doi: https://doi.org/10.1038/d41586-019-00067-3

Wagenmakers, E.-J., Wetzels, R., Borsboom, D., van der Mass, H. L. J., & Kievit, R. A. (2012). An agenda for purely confirmatory research. *Perspectives on Psychological Science, 7*(6), 632–638. doi:10.1177/1745691612463078

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant. *Psychological Science, 22*(11), 1359–1366.https://doi.org/10.1177/0956797611417632

Smaldino, P. E., & McElreath, R. (2016). The natural selection of bad science. *Royal Society open science, 3(*9), 160384.https://doi.org/10.1098/rsos.160384

Week 2. Conceptual and statistical knowledge

Core readings:

Greenland, S., Senn, S. J., Rothman, K. J., Carlin, J. B., Poole, C., Goodman, S. N., & Altman, D. G. (2016). Statistical tests, p values, confidence intervals, and power: A guide to misinterpretations. *European Journal of Epidemiology, 31*(4), 337–50. http://doi.org/10.1007/s10654-016-0149-3

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience, 14*(5), 365-376. https://doi.org/10.1038/nrn3475

Additional readings:

Etz, A., Gronau, Q.F., Dablander, F. et al. (2018). How to become a Bayesian in eight easy steps: An annotated reading list. Psychonomic Bulletin Review, 25, 219–234. https://doi.org/10.3758/s13423-017-1317-5

Flake, J. K., & Fried, E. I. (2019, January 17). Measurement schmeasurement: Questionable measurement practices and how to avoid them. https://doi.org/10.31234/osf.io/hs7wm

Perugini, M., Gallucci, M., & Costantini, G. (2014). Safeguard power as a protection against imprecise power estimates. *Perspectives on Psychological Science, 9,* 319-332.

Week 3. Reproducible analyses

Core readings:

Wilson G, Bryan J, Cranston K, Kitzes J, Nederbragt L, et al. (2017) Good enough practices in scientific computing. *PLOS Computational Biology 13*(6): e1005510. https://doi.org/10.1371/journal.pcbi.1005510

Brown, N. J., & Heathers, J. A. (2016). The GRIM test: A simple technique detects numerous anomalies in the reporting of results in psychology. *Social Psychological and Personality Science,* 1948550616673876. http://journals.sagepub.com/doi/pdf/10.1177/1948550616673876

Additional readings:

Brown, N. J., & Heathers, J. A. (2016). The GRIM test: A simple technique detects numerous anomalies in the reporting of results in psychology. *Social Psychological and Personality Science,* 1948550616673876. http://journals.sagepub.com/doi/pdf/10.1177/1948550616673876

Nuijten, M. B., Van Assen, M. A. L. M., Hartgerink, C. H. J., Epskamp, S., & Wicherts, J. M. (2017). The validity of the tool "statcheck" in discovering statistical reporting inconsistencies. Preprint retrieved from https://psyarxiv.com/tcxaj/.

University of Glasgow's PsyTeachR: https://psyteachr.github.io/msc-data-skills/

Week 4. Preregistration

Core readings:

Nosek, B. A., Ebersole, C. R., DeHaven, A., & Mellor, D. (2018). The Preregistration Revolution. *Proceedings of National Academy Sciences, 115*(11), 2600-2606. https://doi.org/10.1073/pnas.1708274114

Haven, Tamarinde., L. & Van Grootel, Leonie. (2019). Preregistering qualitative research. *Accountability in Research, 26*(3), 229-244., DOI: https://doi.org/10.1080/08989621.2019.1580147

Additional readings:

Chambers, C. D., Feredoes, E., Muthukumaraswamy, S. D., & Etchells, P. (2014). Instead of "playing the game" it is time to change the rules: Registered Reports at AIMS Neuroscience and beyond. *AIMS Neuroscience, 1*(1), 4–17. DOI: 10.3934/Neuroscience2014.1.4

Lin, W., & Green, D. P. (2016). Standard operating procedures: A safety net for pre-analysis plans. *PS: Political Science & Politics, 49*(3), 495-500.

A researcher's experiences of preregistration: https://www.cos.io/blog/one-preregistration-rule-them-all

Week 5. FAIR data and materials

Core readings:

Levenstein, M. C., & Lyle, J. A. (2018). Data: Sharing Is Caring. *Advances in Methods and Practices in Psychological Science, 1*(1), 95–103. https://doi.org/10.1177/2515245918758319

Gilmore, R. O., Kennedy, J. L., & Adolph, K. E. (2018). Practical solutions for sharing data and materials from psychological research. *Advances in Methods and Practices in Psychological Science, 1*(1), 121–130. https://doi.org/10.1177/2515245917746500

Additional readings:

Hardwicke, T. E., Mathur, M. B., MacDonald, K., Nilsonne, G., Banks, G. C., Kidwell, M. C., ... & Lenne, R. L. (2018). Data availability, reusability, and analytic reproducibility: Evaluating the impact of a mandatory open data policy at the journal Cognition. *Royal Society Open Science, 5*(8), 180448. http://dx.doi.org/10.1098/rsos.180448

Rouder, J. N. (2016). The what, why, and how of born open data. *Behavior Research Methods, 48,* 1062–1069. doi:10.3758/s13428-015-0630-z

Soderberg, C. K. (2018). Using OSF to Share Data: A Step-by-Step Guide. *Advances in Methods and Practices in Psychological Science, 1*(1), 115–120. https://doi.org/10.1177/2515245918757689

Week 6. Replication research

Core readings:

Klein, R. A., Vianello, M., Hasselman, F., Adams, B. G., Adams, R. B., Alper, S., … Nosek, B. A. (2018). Many Labs 2: Investigating Variation in Replicability Across Samples and Settings. *Advances in Methods and Practices in Psychological Science, 1*(4), 443–490. https://doi.org/10.1177/2515245918810225

Grahe, J. E., Reifman, A., Hermann, A. D., Walker, M., Oleson, K. C., Nario-Redmond, M., & Wiebe, R. P. (2012). Harnessing the undiscovered resource of student research projects. *Perspectives on Psychological Science, 7*(6), 605–607. https://doi.org/10.1177/1745691612459057

Additional readings:

Fidler, F., & Wilcox, J. (2018). Reproducibility of scientific results. In E. N. Zalta (Ed.), T*he Stanford encyclopedia of philosophy* (Winter 2018). Metaphysics

Research Lab, Stanford University. https://plato.stanford.edu/archives/win2018/entries/scientific-reproducibility/

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716. DOI: 10.1126/science.aac4716

Van Bavel, J. J., Mende-Siedlecki, P., Brady, W. J., & Reinero, D. A. (2016). Contextual sensitivity in scientific reproducibility. *Proceedings of the National Academy of Sciences, 113*(23), 6454-6459. https://doi.org/10.1073/pnas.1521897113

Week 7. Academic life and culture

Core readings:

Bol, T., de Vaan, M., & van de Rijt, A. (2018). The Matthew effect in science funding. *Proceedings of the National Academy of Sciences, 115*(19), 4887-4890. https://doi.org/10.1073/pnas.1719557115

Woolston (2020) Pandemic darkens postdocs' work and career hopes https://www.nature.com/articles/d41586-020-02548-2

Woolston (2020) PhDs: the tortuous truth https://www.nature.com/articles/d41586-019-03459-7

Additional readings:

Kim, E., & Patterson, S. (2020). The Pandemic and Gender Inequality in Academia. Available at SSRN 3666587. http://dx.doi.org/10.2139/ssrn.3666587

Bahlai, C., Bartlett, L. J., Burgio, K. R., Fournier, A., Keiser, C. N., Poisot, T., & Whitney, K. S. (2019). Open science isn't always open to all scientists. *American Scientist, 107*(2), 78-82. https://doi.org/10.1511/2019.107.2.78

Hart, D. D., & Silka, L. (2020). Rebuilding the ivory tower: bottom-up experiment in aligning research with societal needs. *Issues Sci Technol, 36*(3), 64-70. https://issues.org/aligning-research-with-societal-needs/

Week 8. Pedagogy

Core readings:

Chopik, W. J., Bremner, R. H., Defever, A. M., & Keller, V. N. (2018). How (and whether) to teach undergraduates about the replication crisis in psychological science. *Teaching of Psychology, 45*(2), 158–163. https://doi.org/10.1177/0098628318762900

Frank, M. C., & Saxe, R. (2012). Teaching replication. *Perspectives on Psychological Science, 7*(6), 600–604. https://doi.org/10.1177/1745691612460686

Wagge, J. R., Brandt, M. J., Lazarevic, L. B., Legate, N., Christopherson, C., Wiggins, B., & Grahe, J. E. (2019). Publishing research with undergraduate students via replication work: The collaborative replications and education project. *Frontiers in psychology, 10*, 247.

Additional readings:

Garcia, L., Batut, B., Burke, M. L., Kuzak, M., Psomopoulos, F., Arcila, R., ... & del Angel, V. D. (2020). Ten simple rules for making training materials FAIR.

Week 9. Student presentations

This week we will have student presentations.

Other helpful links and resources:

Websites:

https://forrt.org/

Center for Open Science

Society for the Improvement of Psychological Science

Academics for Black Survival and Wellness

ReproducibiliTea Journal Clubs

Podcasts:

The Black Goat

ReproducibiliTEA podcast

Everything Hertz

Juice and Squeeze

Acknowledgements:

Much of the inspiration for this syllabi was drawn from this excellent collection of syllabi relating to open and reproducible research (https://osf.io/vkhbt/). We took particular inspiration from Professor Strand's (https://osf.io/9v2sy/), and Professor Sanjay's syllabus. Future iterations hope to include the efforts of many other educators, please send us an email with suggestions.