Open Science for Veterinary Education

Supporting materials for the Open Science for VetEd Workshop at VetEd 2021
(<https://veted2021.org/>)

Jill R D MacKay

Royal (Dick) School of Veterinary Studies

The University of Edinburgh

jill.mackay@ed.ac.uk

Twitter: @jilly_mackay

Abstract:

“Open Science” encourages researchers to improve the reliability, repeatability and reproducibility of results. While stemming from the reproducibility crisis in psychology, open science is relevant for all fields. In education research these practices include pre-registering experimental designs, sharing analyses where appropriate, and pre-printing research report. How can veterinary education implement these lessons? In this short report accompanying the ‘Open Science for VetEd’ workshop, hosted at the VetEd 2021 Annual Conference, I discuss what opportunities open science presents for veterinary education researchers.

Introduction

The ‘reproducibility crisis’ (also known as the replication crisis) is the name given to a phenomenon of concern in research. It describes the recent findings that many pieces of published research may not be reliable, or even claimed as ‘false findings’¹. There may be many underlying reasons for this, from the innocent: a lack of understanding of statistical analysis or research design^{2,3}; to the concerning: researchers may be consciously or unconsciously obscuring or concealing findings to publish research that may otherwise not be of publishable quality^{4–6}. In practice, this has resulted in many eye-catching claims published in high-impact journals being shown to be poorly replicated⁷. While the reproducibility crisis first gathered steam in the psychological and applied behavioural science⁸, it is now receiving serious attention in the ‘harder’ sciences, including quantum computing⁹ and a large-scale replication of various cancer biology findings¹⁰.

Many researchers, particularly those educated in highly positivistic or ‘hard’ science models¹¹ are highly familiar with the ‘hypothetico-deductive’ model (Figure 1) of the scientific method¹².

Figure 1: A generalised outline of the hypothetico-deductive model for scientific discovery

This model, alongside the highly incentivised drive for publication (publish or perish¹³), is vulnerable to the HARKing practice (hypothesizing after results are known¹⁴), which has been speculated to be a fundamental cause of the reproducibility crisis¹⁵. After running a study and exploring the results, researchers may be tempted to retrospectively create a hypothesis to fit their findings.

Does VetEd Need Open Science?

Veterinary education research is a necessarily interdisciplinary area of research, requiring an understanding of veterinary science, educational research, psychology, and often many other aspects, such as business research or animal welfare and ethology.

Education research, which is strongly related to the terms Scholarship of Learning and Teaching (SoTL) and Discipline Based Educational Research (DBER), explores the practices around learning and teaching to improve the experience and outcomes for educators and students^{16,17}. In practice, these fields all draw from educational psychology and reflective and philosophical practice to create a truly interdisciplinary field of study¹⁸. In veterinary education research, we are mainly interested in whether veterinary students are becoming competent veterinarians, and their learning experience in that journey. The potential for doubting veterinary education research findings is one that requires careful scrutiny.

In general, veterinary education research is aiming to create as many excellent vets as possible with a positive learning experience. This is not always easy. What is 'excellent' and how do we define 'most'? How do we measure attainment or enjoyment? Is the students' experience in the classroom more important than what their degree enables them to do after? Issues of validity and reliability in veterinary education are already intensively discussed in veterinary assessment^{19,20}, but to the author's knowledge, there have been no published report on the reproducibility of research findings in veterinary education. We do know, however, that within the veterinary education community, there are concerns regarding the quality of research²¹, particularly in how best to support new researchers into the practice. It may be fair to say that this is a good time in the field of veterinary research to reflect on our practice and explore what can be done to facilitate better research in future. With more veterinary programmes opening in the United Kingdom²², we are well-placed to pay attention to the developments in related fields, and make use of their own experiences to improve the quality and experience of the veterinarians under our care.

Questionable research practices have been defined⁵ as including: failing to report all of a study's dependent measures, failing to report all of a study's conditions, collecting more or less data during analysis to support a hypothesis, rounding p values, claiming to have expected unusual findings (HARKing), claiming that demographics have no impact on data, and outright falsification of data. These practices have recently been found to be prevalent among education researchers²³. It is important here to ensure that the push to open research practices does not turn into a witch hunt, while there is little peer-reviewed literature on this, there are some concerning reports that the open research movement may negatively impact researchers careers²⁴. These concerns should be heard, and act as a guide for how we respond to unsettling claims about questionable research practices. These findings should be viewed as feedback with which we can make better decisions as a field. Open science practices are a 'carrot' which should incentivise us to produce more replicable, more robust findings, not a 'stick' that will punish researchers for falling out of line.

What Can VetEd Do With Open Science?

The manifesto for reproducible science¹⁵ details a range of approaches that can be used to support more open research practices. For veterinary education, there are a number that can be integrated into our current practice.

Improve methodology

The manifesto promotes improving methodological training and facilitating access to methodology support. Due to the interdisciplinary nature of veterinary education research it's important that this includes collaborations with relevant practitioners. Collaboration is another key element of the manifesto. This should be supported by vet schools, and supported through the community of practice built up around veterinary education research (see^{21,25}). Supporting research across fields

and schools can support multi-site comparisons and replication across different cohorts. This is particularly valuable with qualitative research, which is often subject to undisclosed and unrecognised bias^{26,27}, and can be harder to critically review for veterinary education researchers more well-versed in quantitative research.

Reporting and Dissemination

To facilitate the clearer reporting of findings, pre-registering, sharing analyses, and pre-printing can be useful tools. Pre-registering is the practice of declaring the research design and intended analyses prior to collecting data. It is very similar to what is requested in most ethical applications, and aims to prevent HARKing or other post data-collection tampering. Pre-registering does not preclude adapting to studies, as you can log why and when changes to protocol were made. While pre-registering was initially considered for study designs more like randomised controlled trials, there are now a wide range of pre-registration templates including qualitative pre-registrations and open-ended registrations for large multi-design projects. A range of potential pre-registration templates can be found on the Open Science Foundation registries website: <https://help.osf.io/hc/en-us/articles/360019738794-Select-a-Registration-Template>.

Pre-registering can also encourage the sharing of analyses. This can be as simple as a description of what variables and what tests you intend to use. However, as more open-source powerful statistical softwares become available such as R, Python and Julia, it is becoming more possible to share full analyses. This allows other researchers to investigate every step of the process, and can also be a great advantage when the data itself cannot be shared, such as in the case of sensitive student data^{28,29}. The production and sharing of reproducible workflows not only benefits the individual researcher, but supports the reproducibility of findings overall³⁰.

To further support dissemination, researchers can also make use of meta-data such as the OrcID (Open Research & Contributor ID) which allows for tracking of research across changes of name, institution, and different archival systems, eliminating ambiguity in citations³¹. While not necessary, they are particularly valuable for early career researchers, or those who may be moving between disciplines, allowing them to 'tag' their work across a range of specialities and institutions.

Finally, dissemination and reporting can be further improved through pre-printing, the process of making articles available prior to peer-review. Pre-printing has a host of benefits³² including enhancing sight of the findings and facilitating open review, improving the transparency of peer review, and facilitating the publication of controversial findings. Pre-printing also allows for the sharing of author's final version manuscripts, as they can be updated post peer-review. This will support the availability of research beyond paywalls. Unfortunately, not all journals support pre-printing. In the author's experience, both Medical Teacher and Journal of Veterinary Medical Education have in 2020-2021 discouraged the use of pre-printing by considering it prior-publication, thus making pre-printed papers unable to be published by those journals. However, other journals, such as Frontiers in Veterinary Science support the use of open publishing approaches. Researchers must be cautious in pre-printing to ensure they are not inadvertently cutting themselves off from their desired audience, but should also participate in journal communities to encourage pre-printing where appropriate.

Conclusions

Veterinary education research is a field which is continuing to grow and develop. It is well-placed to learn from the reproducibility crises in psychology and medicine, and to integrate these lessons into its own practice. Reproducibility is an essential component of good, robust research. This is particularly important in a field like veterinary education research which seeks to produce competent veterinarians. It is vital we continue to look to other fields and incorporate their hard-won revolutions into our own practice.

References

1. Ioannidis JP a. Why most published research findings are false. *PLoS Med.* 2005;2(8):e124. doi:10.1371/journal.pmed.0020124
2. Fanelli D. Is science really facing a reproducibility crisis, and do we need it to? *Proc Natl Acad Sci U S A.* 2018;115(11):2628-2631. doi:10.1073/pnas.1708272114
3. Gilbert DT, King G, Pettigrew S, Wilson TD. Comment on "Estimating the reproducibility of psychological science." *Science (80-).* 2016;351(6277):1037-b. doi:10.1126/science.aad7243
4. Spellman BA. Introduction to the special section: Data, data, everywhere ... especially in my file drawer. *Perspect Psychol Sci.* 2012;7(1):58-59. doi:10.1177/1745691611432124
5. John LK, Loewenstein G, Prelec D. Measuring the Prevalence of Questionable Research Practices With Incentives for Truth Telling. *Psychol Sci.* 2012;23(5):524-532. doi:10.1177/0956797611430953
6. Simmons JP, Nelson LD, Simonsohn U. False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychol Sci.* 2011;22(11):1359-1366. doi:10.1177/0956797611417632
7. Camerer CF, Dreber A, Holzmeister F, et al. Evaluating the replicability of social science experiments in Nature and Science between 2010 and 2015. *Nat Hum Behav.* 2018. doi:10.1038/s41562-018-0399-z
8. Open Science Collaboration. PSYCHOLOGY. Estimating the reproducibility of psychological science. *Science.* 2015;349(6251):aac4716. doi:10.1126/science.aac4716
9. Frolov S. Quantum computing's reproducibility crisis: Majorana fermions. *Nature.* 2021;592:350-352.
10. Errington TM, Iorns E, Gunn W, Tan FE lisabet., Lomax J, Nosek BA. An open investigation of the reproducibility of cancer biology research. *Elife.* 2014;3:1-9. doi:10.7554/eLife.04333
11. Staller KM. Epistemological boot camp: The politics of science and what every qualitative researcher needs to know to survive in the academy. *Qual Soc Work.* 2012;12(4):395-413. doi:10.1177/1473325012450483
12. Davidoff F. We need better ways to create new hypotheses and select those to test. *BMJ.* 2012;345(November):1-2. doi:10.1136/bmj.e7991
13. Clapham P. Publish or perish? *Bioscience.* 2005;55(5):390-391. doi:10.1136/bmj.330.7487.336
14. Kerr NL. HARKing: Hypothesizing After the Results are Known. *Personality Soc Psychol Rev.* 1998;2(3):196-217. doi:10.1002/9781118901731.iecrm0112
15. Munafò MR, Nosek BA, Bishop DVM, et al. A manifesto for reproducible science. *Nat Publ Gr.* 2017;1(January):1-9. doi:10.1038/s41562-016-0021

- 176 16. O'Brien M. Navigating the SoTL Landscape: A Compass, Map and Some Tools for Getting
177 Started. *Int J Scholarsh Teach Learn*. 2008;2(2):1-20.
- 178 17. MacKay JRD. Discipline Based Education Research for Animal Welfare Science. *Front Vet Sci*.
179 2020;7(7). doi:10.3389/fvets.2020.00007
- 180 18. Miller-Young J, Yeo M. Conceptualizing and Communicating SoTL : A Framework for the Field.
181 *Teach Learn Inq*. 2015;3(2):37-53. doi:10.2979/teachlearningqu.3.2.37
- 182 19. Hecker K, Violato C. Validity, reliability, and defensibility of assessments in veterinary
183 education. *J Vet Med Educ*. 2009;36(3):271-275. doi:10.3138/jvme.36.3.271
- 184 20. Rodríguez-Martínez H. Quality commitment and management in veterinary education. *J Vet*
185 *Med Educ*. 2006;33(2):165-171. doi:10.3138/jvme.33.2.165
- 186 21. Baillie S, Rhind S, MacKay J, Murray L, Mossop L. The VetEd Conference: Evolution of an
187 Educational Community of Practice. *J Vet Med Educ*. 2021:e20200154. doi:10.3138/jvme-
188 2020-0154
- 189 22. Anon. Two universities join up to announce plans for new West Midlands vet school. *Vet Rec*.
190 2017;181(4):78-78. doi:10.1136/vr.j3503
- 191 23. Makel MC, Hodges J, Cook BG, Plucker JA. Both Questionable and Open Research Practices
192 Are Prevalent in Education Research. *Educ Res*. March 2021:0013189X2110013.
193 doi:10.3102/0013189X211001356
- 194 24. Pownall M, Talbot C V, Henschel A, et al. *Navigating Open Science as Early Career Feminist*
195 *Researchers*.; 2021.
- 196 25. Baillie S, Rhind S, Mossop L, MacKay J. VetEd: The Evolution of an Educational Community of
197 Practice. In: ; 2019:S2-P11. [https://app.oxfordabstracts.com/events/785/program-](https://app.oxfordabstracts.com/events/785/program-app/submission/115378)
198 [app/submission/115378](https://app.oxfordabstracts.com/events/785/program-app/submission/115378). Accessed December 10, 2019.
- 199 26. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77-101.
200 doi:10.1191/1478088706qp063oa
- 201 27. Twining P, Heller RS, Nussbaum M, Tsai CC. Some guidance on conducting and reporting
202 qualitative studies. *Comput Educ*. 2017;106:A1-A9. doi:10.1016/j.compedu.2016.12.002
- 203 28. Mackay JRD. Freeing the free-text comment : exploring ethical text mining in the higher
204 education sector. In: *Analysing Student Feedback in Higher: Using Text-Mining to Interpret*
205 *the Student Voice Education (In Press)*. Taylor & Francis; 2021:In press.
- 206 29. MacKay JRD. On the Horizon: Making the Best Use of Free Text Data With Shareable Text
207 Mining Analyses. *J Perspect Appl Acad Pract*. 2019;7(1):57-64.
- 208 30. Kitzes J, Turek D, Deniz F. *The Practice of Reproducibility: Case Studies and Lessons from the*
209 *Data-Intensive Sciences*. (Kitzes J, Turek D, Deniz F, eds.). Oakland, California: University of
210 California Press; 2018. <http://www.practicereproduciblresearch.org/>. Accessed March 11,
211 2021.
- 212 31. Haak LL, Fenner M, Paglione L, Pentz E, Ratner H. ORCID: A system to uniquely identify
213 researchers. *Learn Publ*. 2012;25(4):259-264. doi:10.1087/20120404
- 214 32. Bourne PE, Polka JK, Vale RD, Kiley R. Ten simple rules to consider regarding preprint
215 submission. *PLoS Comput Biol*. 2017;13(5):8-13. doi:10.1371/journal.pcbi.1005473