BACK TO FUNDAMENTALS OF RESEARCH

Reliability, Transparency and Reproducibility

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

On May 20, 2024, the University of Bologna held an international event titled: "Back to fundamentals of research: Reliability, Transparency and Reproducibility" with distinguished experts from national and international institutions.
The debate revolved around what it means to perform research responsibly and whether the reproducibility of results can be used as a reliable proxy for research quality.

Through this position paper, the University of Bologna intends to highlight some key messages that emerged from the discussions and point out challenges and recommendations in ensuring reproducibility and trustworthy methodologies in research environments.

Keynotes
Sabina Leonelli
Professor of Philosophy and History of Science, University of Exeter
"Reproducible, reliable and responsible research: How Open Science can help"

Further reading:

Leonelli, S. (2023) 'Philosophy of Open Science'. Elements series. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/9781009416368

Leonelli, S. (2018) 'Re-Thinking Reproducibility as a Criterion for Research Quality'. Research in the History of Economic Thought and Methodology, 36B: 129-46. https://doi.org/10.1108/S0743-41542018000036B009 (Open Access version: http://philsci-archive.pitt.edu/14352/)

Leonelli, S. and Lewandowsky, S. (2023) 'The reproducibility of research in Flanders: Fact finding and recommendations - KVAB Thinkers' report 2022'. KVAB Standpunt 81. ISBN 978 90 656 921 91. Report: https://kvab.be/en/standpunten/de-reproduceerbaarheid-van-het-onderzoek-vlaanderen-feitenonderzoek-en-aanbevelingen

Leonelli, S. (2017) 'Global Data Quality Assessment and the Situated Nature of "Best" Research Practices in Biology'. Data Science Journal, 16(32): 1-11. https://doi.org/10.5334/dsj-2017-032

HIGHLIGHTS FROM THE KEYNOTE PRESENTATIONS

Keynote 1: Sabina Leonelli, Professor of Philosophy and History of Science, University of Exeter
We are witnessing a crisis in quality evaluation: traditional peer review is not incentivized and all existing alternatives have drawbacks (e.g., they are based on voluntary work). Additionally, there is an increased need to select reliable sources and sift through unreliable results and misinformation.
Reproducibility can be a criterion for quality but is not a "magic formula": it does not address systemic issues related to rewards and incentives, and it has different meanings in different research contexts.
Indeed, reproducibility is shaped by at least four aspects that characterize scientific studies and that vary across disciplines: the control over research conditions, the dependence on statistics, the precision of research goals, and the dependence on researchers' judgement. We can identify several kinds of reproducibility: (1) Computational reproducibility, (2) Direct experimental reproducibility, (3) Scoping/Indirect/Hypothetical reproducibility, (4) Reproducible expertise, (5) Reproducible observation.
It is crucial to develop transparent and reproducible research, and open science in general, with diversity as a starting point: inclusion is in fact the first step towards quality and transparency. This can be done by acknowledging multiple perspectives and well-established cultures of openness, supporting openness across publicly and privately funded institutions, investing in understanding scientific motivations for specific habits and preferences and balancing the need for standardization with situational knowledge.

Keynotes
Daniele Fanelli
Professor in Social Research Methods,
Heriot-Watt University
"Reproducibility: there's more complexity than it seems"

Further reading:

Fanelli, D. (2018) 'Is science really facing a reproducibility crisis, and do we need it to?' Proceedings of the National Academy of Sciences (PNAS). https://doi.org/10.1073/pnas.1708272114

Fanelli, D. (2022) 'Is Science in Crisis?', in Lee Jussim, Jon A. Krosnick, and Sean T. Stevens (eds), Research Integrity: Best Practices for the Social and Behavioral Sciences. Oxford University Press. https://doi.org/10.1093/oso/9780190938550.003.0004

Roundtable - The institutional perspective
Moderator:
Alberto Credi
Vice Rector for Research,
University of Bologna

Participants:
Daniele Livon
National Agency for The Evaluation of Universities and Research Institutes - ANVUR
Fabrizio Cobis
Ministry of University and Research - MUR
Marcus Munafò
UK Reproducibility Network
Stanislaw Kistryn
Jagellonian University

Keynote 2: Daniele Fanelli, Professor in Social Research Methods, Heriot-Watt University
Since empirical estimates suggest a high (50-80%) reproducibility rate, suggestions that science faces a "reproducibility crisis" implicitly assume that reproducibility should be very high (e.g. 95%) in any field, regardless of contingent factors. This is clearly unrealistic, since there are numerous "natural" causes of irreproducibility, such as biological variation, the complexity of statistical software, small sample sizes, heterogeneity, the context- dependency of relevant or irrelevant characteristics, and the existence of both theoretical and empirical hypotheses.
Even if we eliminate the intentional causes of irreproducibility, we cannot expect perfect reproducibility: a research study is a complex system, in which methods and phenomena studied may not be completely known by researchers. Further, its structure and complexity differ across different fields and disciplines, level of consensus and maturity, and across social, economic and cultural context. All these aspects make it impossible to establish a baseline for what the rate of reproducibility should be for any given literature. However, without such a baseline, suggestions that we are witnessing a "crisis" are, quite literally, baseless.
Current metascience overlooks important factors, e.g.: replication protocol complexity predicts irreproducibility, predictors of misconduct are highly country-dependent, open science practices fostering reproducibility require costs and infrastructures that are not accessible to everyone. Additionally, they can limit reproducibility, like privacy and ethical issues, and they can have drawbacks, since they can increase bureaucracy and thus complexity to the research system. Therefore, policy reforms such as mandating the sharing of data or the preregistration of studies may sometimes be useless or even damaging, and may foster inequalities across systems, contexts, conditions. To try and counter some of these issues, policies should be light and adaptive to fit the specific needs of particular research disciplines, fields and contexts within them.

ROUNDTABLE 1: THE INSTITUTIONAL PERSPECTIVE

How can different stakeholders (e.g., funders, evaluators) help in promoting reliability, transparency and reproducibility?
- We should focus on the social value and social impact of research – and turn them into criteria to be considered in evaluation.
- We should focus on quality over quantity, also when selecting projects to be funded.

What are the strategies to encourage reliability, transparency and reproducibility and overcome the main obstacles, if any, at the institutional level?
- We must find a way to recognize good research without relying just on numerical indicators.
- Integrity and ethical values are the driving forces behind our research communities. They should be rewarded, while non-compliance should have consequences.
- Reproducibility and transparency allow researchers to earn the respect of their communities and to serve society best. The authoritativeness of scientific and cultural knowledge should be at the core of science policies.

Considering the differences across disciplinary areas, how could reliability, transparency, and reproducibility be translated into evaluation strategies/criteria?
- The Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR) is currently focusing on open access publications and research data, but originality and methodology are also essential

evaluation criteria. Methodology should be clearly understandable and useful to prove the validity of a research hypothesis.
- Qualitative research evaluation should be preferred over quantitative evaluation.
- Evaluation strategies themselves need to be transparent.

What strategies could be adopted to involve researchers in promoting reliability, transparency and reproducibility?
- We should involve researchers who do transparent research in policymaking to recognize and value their work. We should ask them what can be done to improve quality in their specific research environments.
- Institutions need to find seamless processes to make researcher's life easier in making research transparent.
- It is crucial to recognize disciplinary differences: transparency can have different meanings and be implemented into diverse practices.

ROUNDTABLE 2: THE RESEARCHERS' PERSPECTIVE

What are the enablers and main obstacles to improving the reliability, transparency, and reproducibility of your research?
- Requiring the submission of code, data and/or protocols together with an article can strongly encourage research reproducibility.
- In some humanities disciplines, an obstacle is represented by a publishing ecosystem that is still mostly paper-based.

What types of incentives might help encourage and promote practices improving research reliability, transparency and reproducibility?
- Evaluating a wider range of scientific outputs, such as study protocols, would help make transparent and reproducible all those studies that involve qualitative and sensitive data, which are impossible to share. It would help put an end to the "publish and perish" culture and increase research reflexivity.
- It might be useful to think about ways of evaluating the trustworthiness of a research lab or team.

Which transparency and reproducibility good practices from your own field can be translated into other disciplinary contexts?
- Practices relating to Citizen Science and the involvement of society in research are widespread in Cultural Heritage research but could and should be translated elsewhere.
- The principle of "open-by-design" should be adopted across all disciplines. When possible, it allows researchers to share their results with a broader public easily; otherwise, it still fosters good and transparent research practices, which can themselves be shared and formalized as a standard research protocol for instance.

Roundtables - The researchers' perspective (see slides)
Moderator:
Carlo Miniussi
Italian Reproducibility Network,
University of Trento

Participants (all from the University of Bologna):
Francesco Chemello
Department of Pharmacy and Biotechnology:
"Sharing protocols to confirm research reliability"
Giulia Raffaella De Luca
Department of Electrical, Electronic and Information Engineering "Guglielmo Marconi":
"*AI for lung cancer imaging: a FAIRness story*"
Sara Fiorentino
Department of Cultural Heritage:
"Management strategies for cultural heritage at risk"
Maria Teresa Galli
Department of Classical Philology and Italian Studies:
"The critical edition and the transparency of the interpretive process"
Alice Mattoni
Department of Political and Social Sciences:
"The point of view of the BIT-ACT research project, qualitative, developed in unstable contexts and on sensitive topics"
Federico Ruggeri
Department of Computer Science and Engineering:
"Robust and reproducible experimental deep learning setting"

Challenges

The trustworthiness of science.
- The relationship of trust between science and society needs to be strengthened as it is sometimes challenged by unreliable results and misinformation.
- The selection of reliable sources is more crucial and demanding than ever. New technologies and generative AI have added further complexity and (potential) mistrust.

The assessment of research quality.
- Prioritize qualitative over quantitative research evaluation in accordance with CoARA principles.
- Reproducibility could be one of the criteria, but it should not be considered the only parameter.
- Several aspects characterize scientific studies, and they vary across disciplines that may affect the reproducibility of a study: an uncritical approach risks favoring the methods of specific disciplines and thus fostering inequalities.

The institutional change towards a more reliable, transparent and reproducible academia.
- National and international evaluation systems need to embrace a positive change as researchers cannot change the current "publish or perish" ecosystem alone.
- Research Performing Organizations (RPOs) must adapt services and policies to promote responsible research and support individual researchers to enhance the quality of their research.
- Models of transparency and openness that create unnecessary complexity with no clear advantages need to be carefully avoided.

Scientific Committee

Prof. Alberto Credi
Vice Rector for Research, Department of Industrial Chemistry "Toso Montanari"

Prof. Francesca Masini, Rector's Delegate for Open Science and Research Data, Department of Modern Languages, Literatures, and Cultures

Prof. Stefano Diciotti, Department of Electrical, Electronic, and Information Engineering "Guglielmo Marconi"

Prof. Monica Forni, Department of Medical and Surgical Sciences

Prof. Silvio Peroni, Department of Classical Philology and Italian Studies

Recommendations

Fostering the social value of research and improving how it is perceived by society.
- Transparency and reproducibility help demonstrate the reliability of research and thus improve the authoritativeness of scientific and cultural knowledge.
- Ethics and research integrity must drive the researchers in making science.
- Researchers should become much more conscious of the social impact of science and thus aware of their responsibility. Each researcher is individually responsible for their research and needs to conduct it according to The European Code of Conduct for Research Integrity, other ethical codes of conduct and coherently with institutional policies, and with the objectives of the RPO.
- Researchers should adopt an RRI approach (Responsible Research and Innovation) that emphasizes the importance of a reflective and inclusive relationship between science and society with the goal of making research and innovation inclusive and sustainable.

Assessing the quality of research respecting the diversity across different fields of knowledge.
- Research assessment needs to acknowledge multiple perspectives and well-established scientific cultures, understanding the motivations for specific habits and preferences in research.
- Research assessment criteria need to consider disciplinary differences adaptively.
- A more comprehensive range of scientific outputs, such as data, protocols and, crucially, research methodologies, need to be considered for evaluation to promote reliable, transparent and reproducible research.
- Reproducibility could be one of the possible criteria, but it is not applicable to all research contexts and should be operationalized as an adaptive parameter.

Creating an environment conducive to reliability, transparency and reproducibility.
- Processes and services should be streamlined to make transparent and reproducible research as easy as possible, avoiding added bureaucracy and complexity.
- Research policies should be simple to understand, apply, and adapt to different disciplines. Where possible, researchers should be involved in policymaking.
- Early-career researchers should be supported, best practices, including transparent and robust methodologies, should be recognized and rewarded.
- Reliability, transparency, and reproducibility in research should be supported via national and international funding.