TIER2 Enhancing Trust, Integrity and Efficiency in Research through next-level Reproducibility

Strategic priorities for reproducibility reform: The case of TIER2

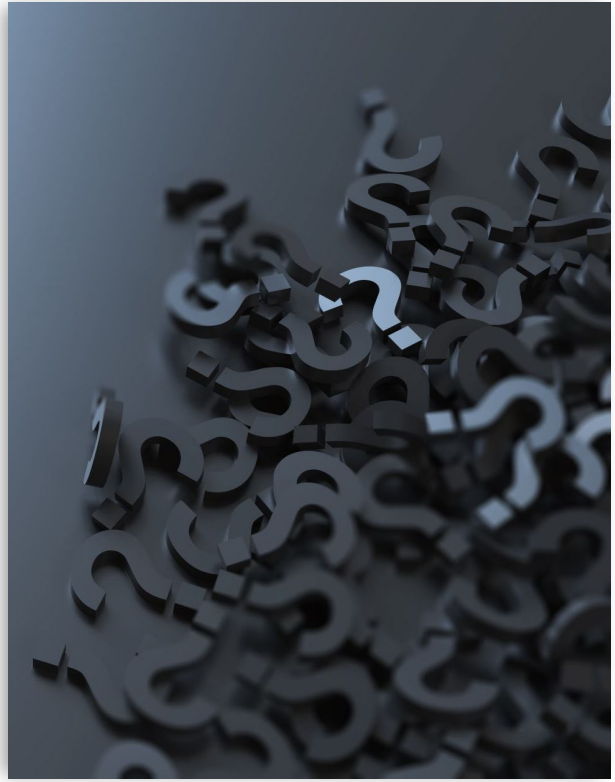
Tony Ross-Hellauer

Danish Reproducibility Network Launch Event, 24th August 2023

Funded by the European Union.
Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission.
Neither the EU nor the EC can be held responsible for them.

What is reproducibility?

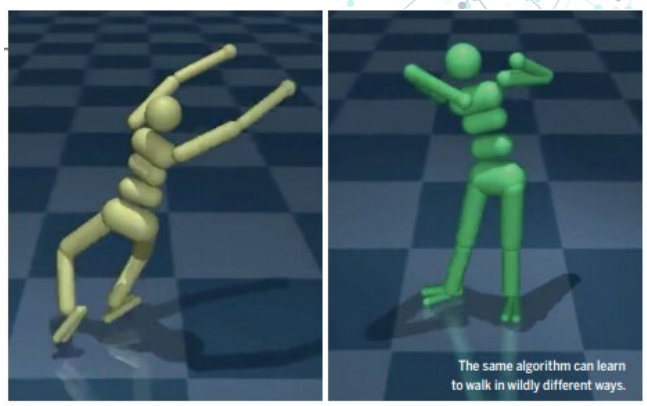
- Often considered a cornerstone of *scientific* enquiry
- Definitions vary (a lot)
  - Not only in using the same words for different things (reproducibility / replication) but also in taxonomies for the various aspects of research that can be made reproducible/replicable
- Key distinction between:
  - *Methods reproducibility:* Work that is reproducible in principle, meaning that there is sufficient documentation and sharing of methods, protocols, data, code, etc. to enable the work to be reproduced.
  - *Results reproducibility:* Work that actually successfully reproduces/replicates when a study is repeated, i.e., the results are found to be sufficiently similar across both studies.
- At its highest level, just obtaining consistent results when repeating experiments and analyses



Reliability of findings are in question

Why Most Published Research Findings Are False

John P. A. Ioannidis



COMPUTER SCIENCE

Artificial intelligence faces reproducibility crisis

Unpublished code and sensitivity to training conditions make many claims hard to verify

nature REVIEWS DRUG DISCOVERY

Believe it or not: how much can we rely on published data on potential drug targets?

Florian Prinz, Thomas Schlange & Khusru Asadullah

BMJ

BMJ 2014;348:g3725 doi: 10.1136/bmj.g3725 (Published 13 June 2014)

Evidence based medicine: a movement in crisis?

Trisha Greenhalgh and colleagues argue that, although evidence based medicine has had many benefits, it has also had some negative unintended consequences. They offer a preliminary agenda for the movement's renaissance, refocusing on providing useable evidence that can be combined with context and professional expertise so that individual patients get optimal treatment

Power failure: why small sample size undermines the reliability of neuroscience

Katherine S. Button[1,2], John P. A. Ioannidis[3], Claire Mokrysz[1], Brian A. Nosek[4], Jonathan Flint[5], Emma S. J. Robinson[6] and Marcus R. Munafò[1]

Causes

- Lack of transparency
- Poor reporting of methods
- Lack of sharing of data/code
- Lack of reproduction/replication studies
- Publication bias towards reporting of positive results
- Questionable research practices

Funders are taking note

2020 European Commission Scoping Report* recommended dedicated **funding lines** , testing and scaling of **interventions** , **capacity -building** , alignment of **policies**

- 2022 EC Horizon Europe call for Research and Innovation Projects on the theme "**Increasing the reproducibility of scientific results** "
  - **3 projects** funded for total **~6m Euros** from EC and UKRI

siris TIER2 iRISE

* European Commission, Directorate-General for Research and Innovation, Baker, L., Cristea, I., Errington, T., et al., *Reproducibility of scientific results in the EU : scoping report*, Lusoli, W. (editor), Publications Office, 2020, **https://data.europa.eu/doi/10.2777/341654**

TIER2 in a nutshell

TIER2: enhancing Trust, Integrity And Efficiency In Research through next-level Reproducibility

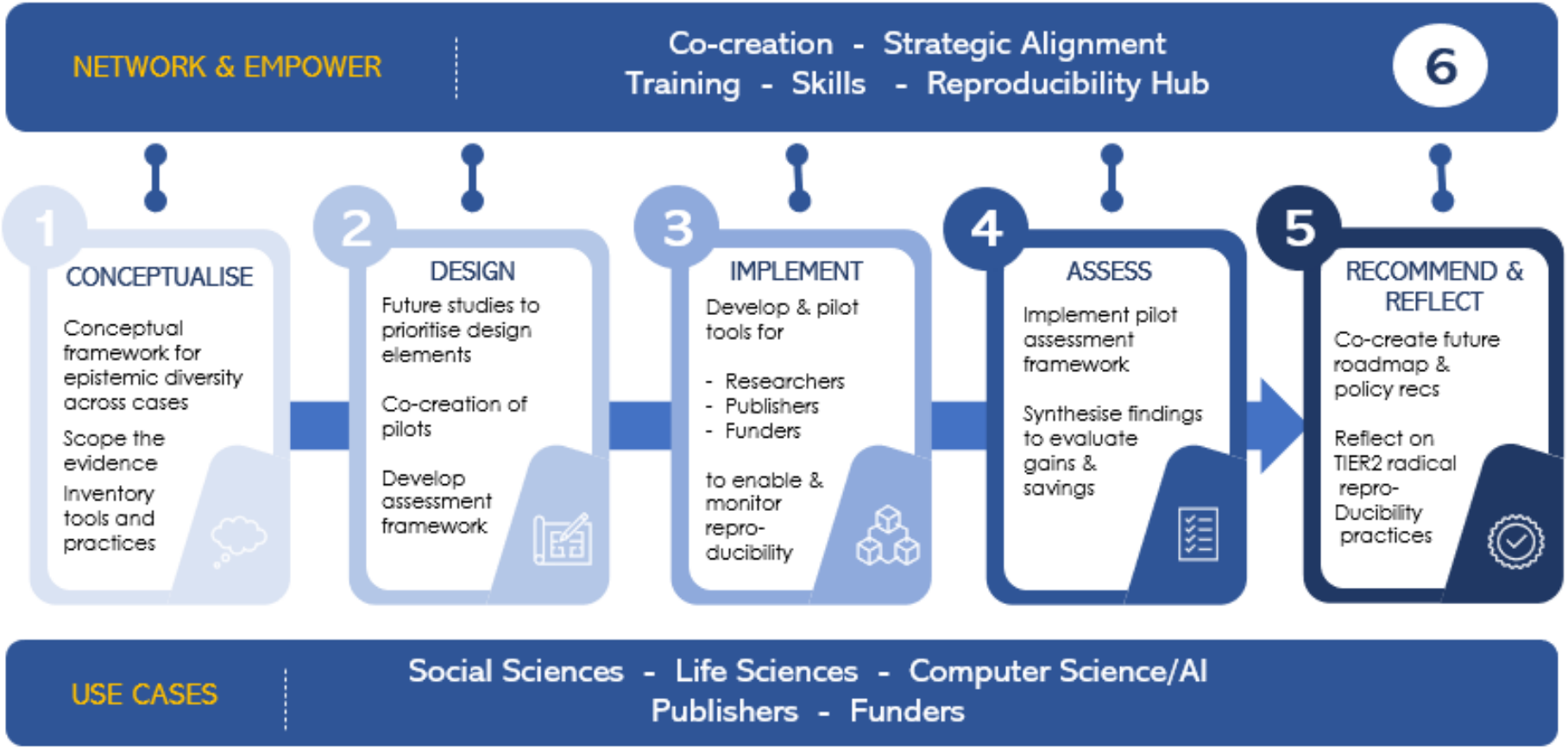
- Investigate reproducibility in social, life, computer sciences, plus funder and publisher contexts
- Co-creative approach to creating and evaluating new reproducibility tools and practices
- 10 partners from across Europe
- 2 million Euros from EC Horizon Europe and UKRI
- January 2023 to December 2025

http://tier2-project.eu/

TIER2

Organisation	Principal investigator
Know-Center GmbH, Austria	Tony Ross-Hellauer (m)
Athena Research Center, Greece	Thanasis Vergoulis (m)
Stichting Vumc, Netherlands	Joeri Tijdink (m)
Aarhus University, Denmark	Jesper Schneider (m)
Pensoft Publishing, Bulgaria	Lyubomir Penev (m)
GESIS, Germany	Hajira Jabeen (f)
OpenAIRE, EU	Natalia Manola (f)
Charite, Germany	Alexandra Bannach-Brown (f)
University of Oxford, UK	Susanna-Assunta Sansone (f)
Biomedical Sciences Research Center Alexander Fleming, Greece	Martin Reczko (m)

TIER2 methodological steps



Especially over the last 10 years, lots of new and exciting research, tools and practices have been put in place to improve levels of reproducibility.

But, taking stock, there is broader potential …

Strategic priorities: The TIER2 approach

RIO Research Ideas and Outcomes 8: e98457
doi: 10.3897/rio.8.e98457

OPEN ACCESS

Grant Proposal

TIER2: enhancing Trust, Integrity and Efficiency in Research through next-level Reproducibility

Tony Ross-Hellauer‡, Thomas Klebel‡, Alexandra Bannach-Brown§, Serge P.J.M. Horbach|, Hajira Jabeen¶, Natalia Manola#, Teodor Metodiev¤, Haris Papageorgiou«, Martin Reczko», Susanna-Assunta Sansone˄, Jesper Schneider|, Joeri Tijdink˅, Thanasis Vergoulis«

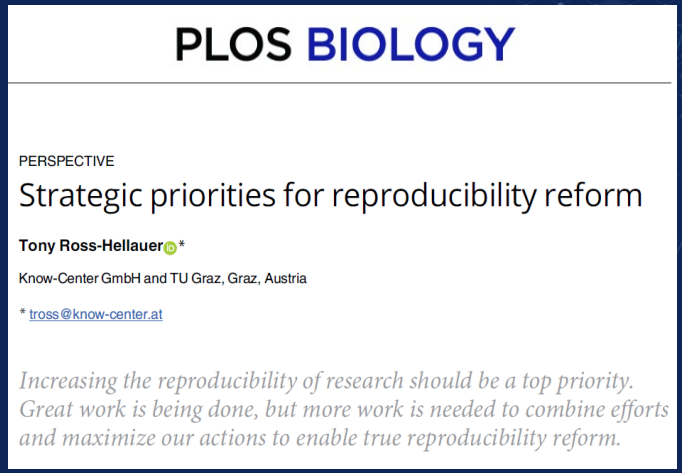
‡ Know-Center GmbH Research Center for Data-Driven Business & Big Data Analytics, Graz, Austria
§ Charite - Universitaetsmedizin Berlin, Berlin, Germany
| Aarhus University, Aarhus, Denmark
¶ GESIS-Leibniz-Institut Für Sozialwissenschaften, Mannheim, Germany
# OpenAIRE AMKE, Athens, Greece
¤ Pensoft Publishers, Sofia, Bulgaria
« Athena - Athena Research & Innovation Center In Information Communication & Knowledge Technologies, Athens, Greece
» Biomedical Sciences Research Center Alexander Fleming, Vari, Greece
˄ Oxford e-Research Centre, Department of Engineering Science, University of Oxford, Oxford, United Kingdom
˅ Stichting VUmc, Amsterdam, Netherlands

Corresponding author: Tony Ross-Hellauer (tross@know-center.at)

Reviewable v 1

Received: 07 Dec 2022 | Published: 08 Dec 2022

Ross-Hellauer T et al. (2022) TIER2: enhancing Trust, Integrity and Efficiency in Research through next-level Reproducibility. Research Ideas and Outcomes 8: e98457. https://doi.org/10.3897/rio.8.e98457



PLOS BIOLOGY

PERSPECTIVE

Strategic priorities for reproducibility reform

Tony Ross-Hellauer *

Know-Center GmbH and TU Graz, Graz, Austria

* tross@know-center.at

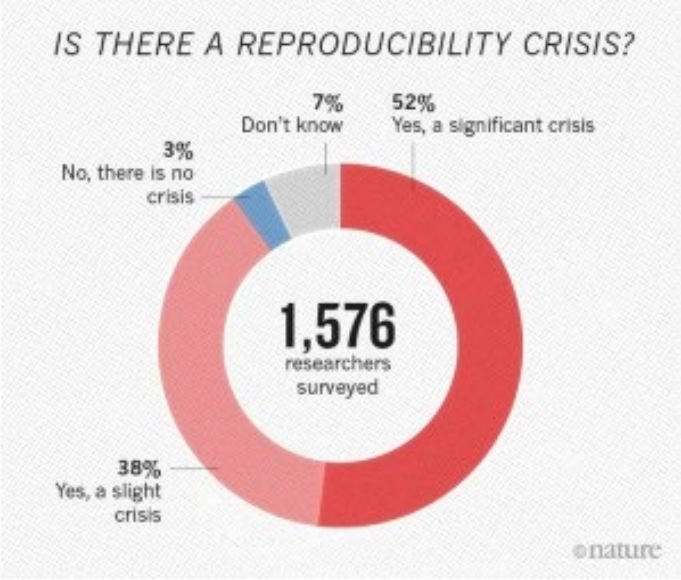
Increasing the reproducibility of research should be a top priority. Great work is being done, but more work is needed to combine efforts and maximize our actions to enable true reproducibility reform.

Ross-Hellauer T (2023) Strategic priorities for reproducibility reform. PLOS Biology 21(1): https://doi.org/10.1371/journal.pbio.3001943

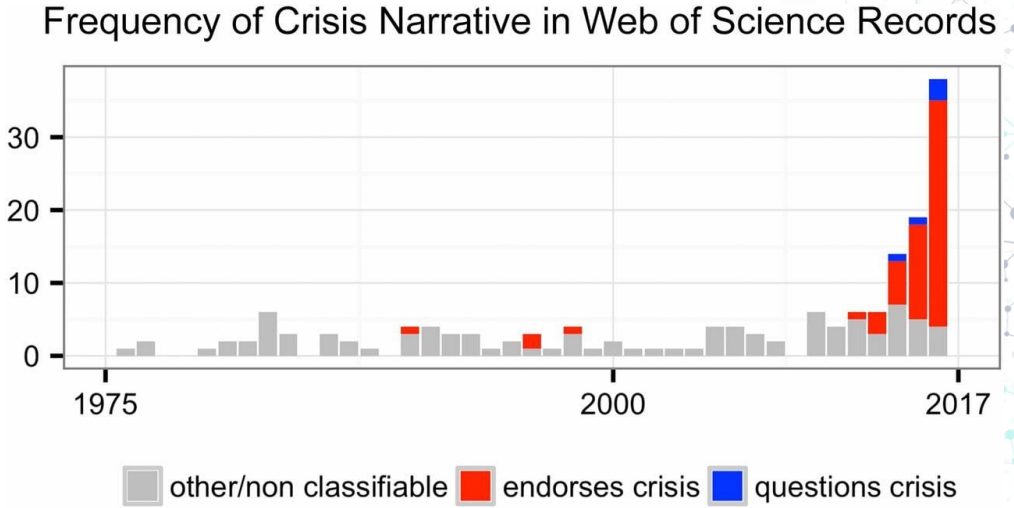
TIER2

1. Frame reproducibility as a reformation, not a crisis

Research in crisis?

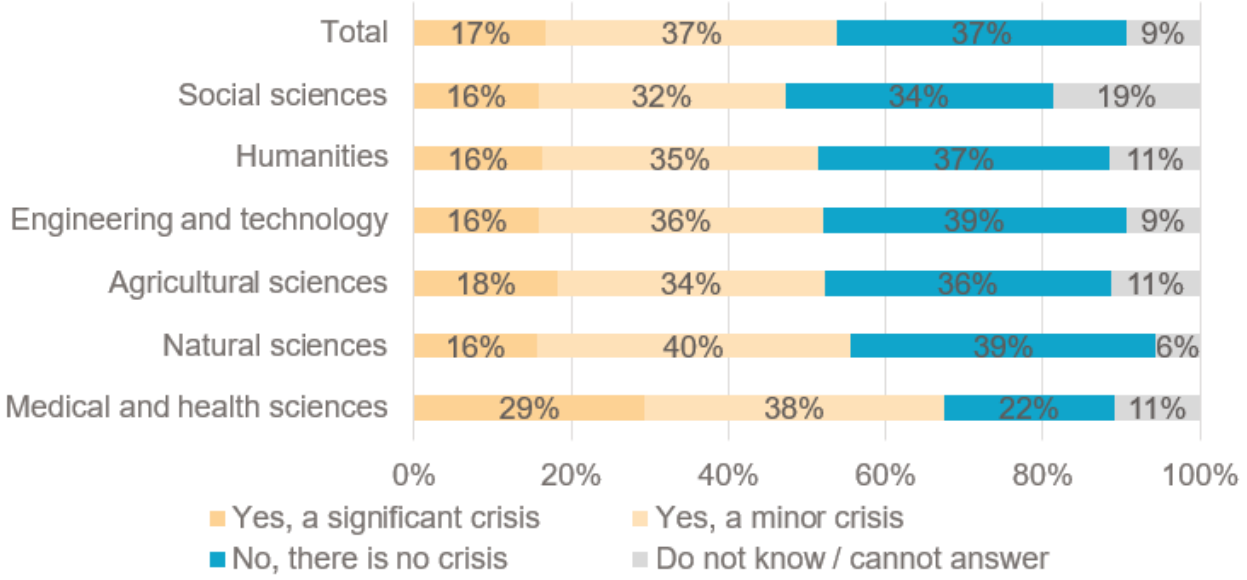


Baker, M. 1,500 scientists lift the lid on reproducibility. Nature 533, 452–454 (2016). https://doi.org/10.1038/533452a



Fanelli D. Is science really facing a reproducibility crisis, and do we need it to? Proc Natl Acad Sci USA. 2018;115(11):2628–2631. pmid:29531051

2022 – Less so?



European Commission, Directorate-General for Research and Innovation. 2022. Assessing the reproducibility of research results in EU Framework Programmes for Research final report. https://data.europa.eu/doi/10.2777/186782

Crisis narrative misguided?

- Fanelli (2018) suggests “crisis narrative is at least partially misguided”
- Specifically that “issues with research integrity and reproducibility are:
  - not distorting the majority of the literature, in science as a whole as well as within any given discipline;
  - heterogeneously distributed across subfields in any given area, which suggests that generalizations are unjustified; and
  - not growing, as the crisis narrative would presuppose.”

Fanelli D. Is science really facing a reproducibility crisis, and do we need it to? Proc Natl Acad Sci USA. 2018;115(11):2628–2631. pmid:29531051

TIER2

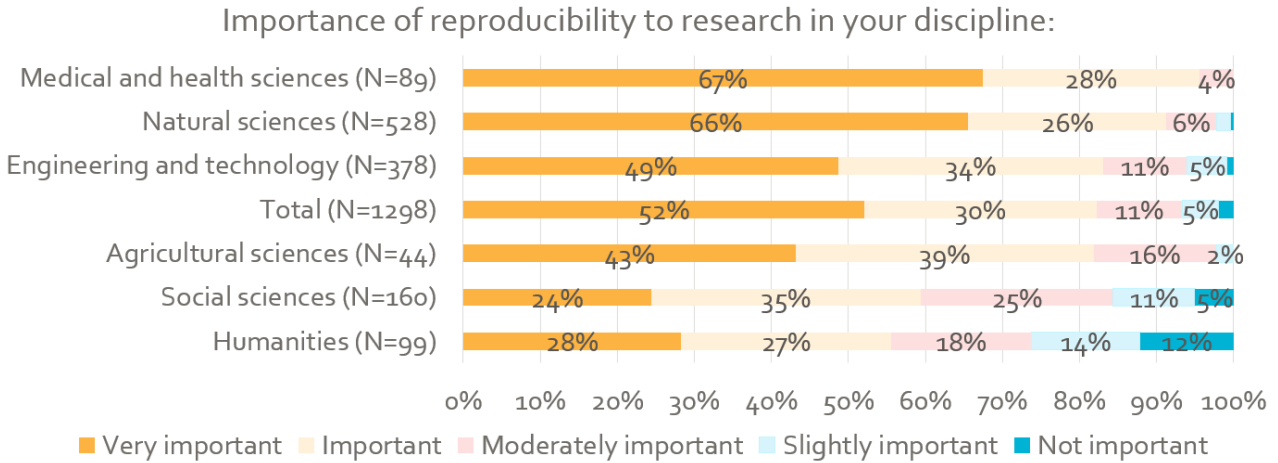
An opportunity not a crisis?

"Rather than viewing the current debate around the reproducibility and replicability of research findings as a "crisis", it is more constructive in our view to frame it as an opportunity to reflect on which aspects of relevant working practices continue to be effective, which can be improved, and which new ways of working can beneficially be introduced to the research ecosystem."

Munafò, M.R., Chambers, C., Collins, A. et al. The reproducibility debate is an opportunity, not a crisis. BMC Res Notes 15, 43 (2022). https://doi.org/10.1186/s13104-022-05942-3

2. Centre epistemic diversity.

Differences across disciplines



European Commission, Directorate-General for Research and Innovation. 2022. Assessing the reproducibility of research results in EU Framework Programmes for Research final report. https://data.europa.eu/doi/10.2777/186782

Forms of reproducibility across research contexts

- Discussion on reproducibility led by specific disciplines like medicine & psychology
- Yet, per Leonelli: “Reproducibility for data-intensive research comes in a variety of forms geared to specific features of the research environment”, e.g.,:
  - Assumed degree of control over research conditions
  - Dependence on statistics as inferential tool
  - Precision of the research goals
  - Dependence on researchers’ judgement”
- And what of non-data intensive research? (Open question)

Leonelli, S. (2018), "Rethinking Reproducibility as a Criterion for Research Quality", https://doi.org/10.1108/S0743-41542018000036B009

Leonelli - Sources of epistemic diversity relevant to Open Science*

MATERIAL
- Target objects
- Materials

CONCEPTUAL

METHODOLOGICAL
- Standards
- Methods

INFRASTRACTURAL (capacity res. environment)
- Funding
- Infrastructures
- ICT and other technologies
- Mobility and transports

SOCIO-CULTURAL
- System of research assessment (locally and nationally)
- Legal and ethical accountability
- Geo-political location
- Language
- Values and goals
- Characteristics of researchers (gender, class, ethnicity, age, physical ability..)

INSTITUTIONAL
- Career stage and power dynamics
- Institutional and administrative support
- Field of study and related norms / venues for publishing and exchange
- Intellectual property regimes

Leonelli S. 2021. Open Science and Epistemic Diversity: Friends or Foes? DOI: 10.1017/psa.2022.45

In TIER2 …

- Investigation of relevance and feasibility of reproducibility across modes of knowledge production a major theme
  - Theoretical investigation led by Jesper Schneider, Aarhus University (presenting later)
- “Future studies” investigations with researchers, publishers and funders to investigate views of what is necessary to increase reproducibility
- Pilots of new tools in various contexts (social, life, computer sciences + funders and publishers)

3. Systematize evidence for informed policy across contexts

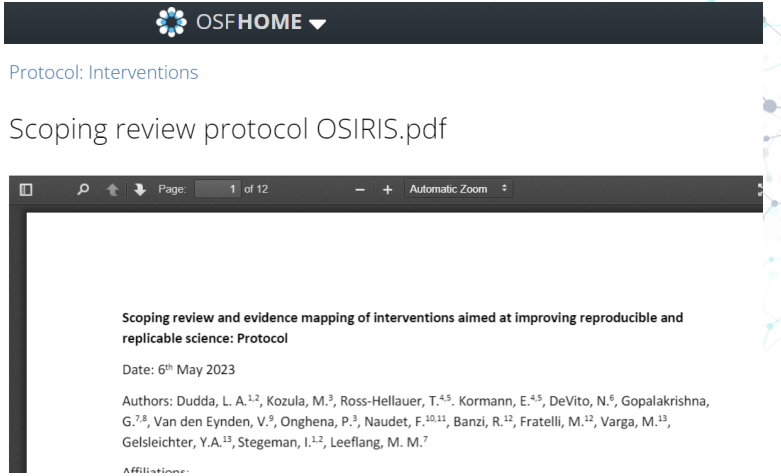
Q. How do reproducibility interventions affect outcomes across contexts?

- Currently, much of the debate and evidence comes from a relatively narrow slice of the research spectrum
- Need to acknowledge that across contexts (e.g., disciplinary, geographic, demographic), communities face different problems and are at different levels of readiness
- Even within research areas, not all interventions equally effective
  - E.g., Vazire (2018) suggests that although increased reproducibility may raise productivity in general, productivity may be reduced in some subfields
- What generalities can we find in common issues across disciplines, and what specificities?

Vazire, S. 2018. “Implications of the Credibility Revolution for Productivity, Creativity, & Progress.” Perspectives on Psychological Science 13 (4): 411–17. https://doi.org/10.1177/1745691617751884.

Scoping the evidence in TIER2

- Scoping review and evidence mapping of interventions aimed at improving reproducible and replicable science
- Study underway (collaboration with OSIRIS project)
- All disciplines and contexts (incl. publishing, funding)
- Currently reviewing >25,000 records
- Protocol online: https://osf.io/rhe9k



TIER2 pilots on new tools and interventions *(under development!)

Researchers

- **Reproducibility hub** (resources for awareness, training, checklists hosted via Embassy of Good Science)
- **Reproducible workflow tools**
  - "Schema" extension for Life Science
  - Methods Hub for computational social science
  - Tools for transparency in qualitative research

Funders

- **Reproducibility promotion plans** for funder policy development
- Reproducibility **monitoring dashboard** – indicators of levels of Open Science and reproducibility practices
- **Reproducibility management planning tool** (extension of Data Management Plan concept)

Publishers

- **Data Availability Statements** (intervention to improve clarity/efficacy of Data Availability Statements)
- Training/education on **workflows for editorial checks on data**

TIER2

4. Work together to boost capacity at all levels

Elements of research culture change (from Nosek, 2019)

- Treat reproducibility as a “full stack” problem
- Joined-up approaches for coordinated change at all levels
- Building on the great strides already made
  - Reproducibility Networks
  - **Open** infras, e.g., OSF, EOSC
  - Research assessment reform (COARA)

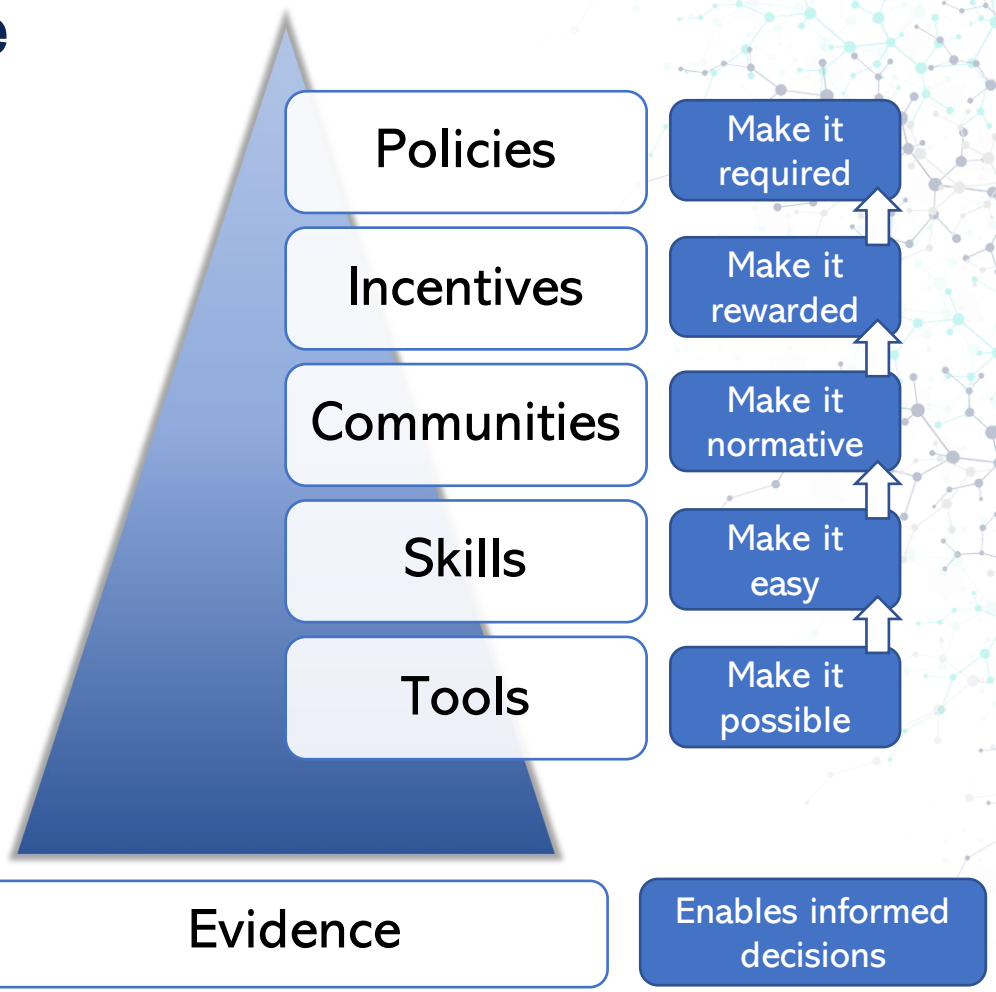


Figure adapted from CC BY figure in: Nosek, B. 2019. “Strategy for Culture Change.”2019. https://www.cos.io/blog/strategy-for-culture-change.

TIER2 is well linked to, and empowers, other networks

Examples:

- Reproducibility Networks
  - via several National RNs, incl UKRN
- Research Data Alliance (RDA)
  - via the FAIRsharing WG, OpenAIRE
- EOSC and other European Research Infrastructures
  - via OpenAIRE and FAIRsharing
- Center for Open Science (COS)
  - we share members between COS Board of Directors and TIER2 Advisory Board
- Publisher and Funder networks
- Fellow EC reproducibility projects iRISE & OSIRIS

RN

RDA

RESEARCH DATA ALLIANCE

eosc

COS

CENTER FOR OPEN SCIENCE

TIER2

Collaboration with sister projects

- Evidence scoping (interventions, outcomes)
- Assessment/monitoring indicators
- Events, community-building
- Self-reflection on own practices
- Investigation of new interventions

siris TIER2 iRISE

iRISE

5. Emphasize inclusion to minimize unintended consequences and maximize equitable transition

Resources and inequalities

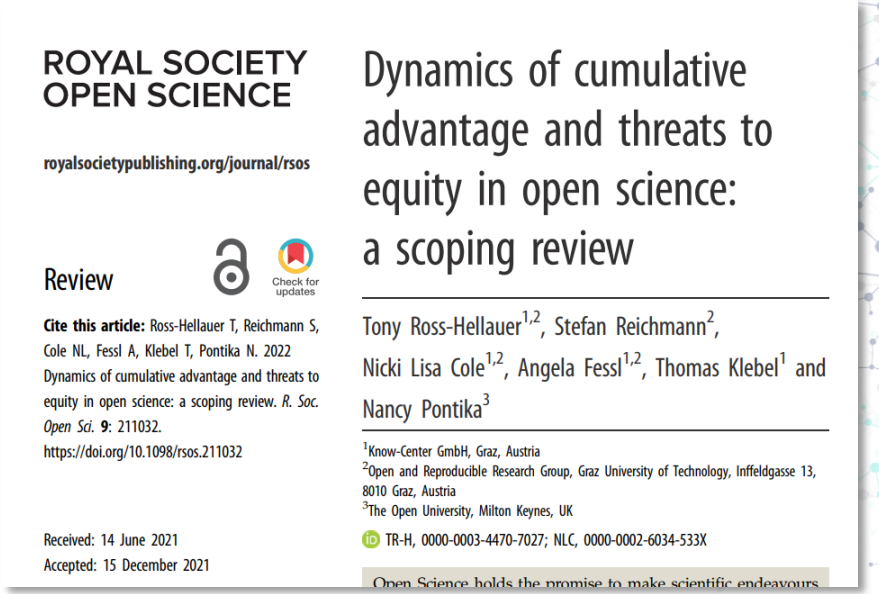
- Open and reproducible research needs **resources** to build infrastructures, skills, communities, incentives, policies
- Structural inequalities persist across regions and demographics
- Access to resources not equally distributed
  - **Structurally inequalities**
  - Mechanisms of **cumulative advantage** (rich get richer)

Issues of equity in Open Science

Synthesis of results from 268 relevant studies

Many (diverse) threats:

- Costs of participation
- Discriminatory APC OA
- Cumulative data inequalities
- Platform-logic of Open Science
- Lack of reward structures
- Exclusion of societal voices



ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Review

Check for updates

Cite this article: Ross-Hellauer T, Reichmann S, Cole NL, Fessl A, Klebel T, Pontika N. 2022 Dynamics of cumulative advantage and threats to equity in open science: a scoping review. *R. Soc. Open Sci.* **9**: 211032. https://doi.org/10.1098/rsos.211032

Received: 14 June 2021
Accepted: 15 December 2021

Dynamics of cumulative advantage and threats to equity in open science: a scoping review

Tony Ross-Hellauer[1,2], Stefan Reichmann[2], Nicki Lisa Cole[1,2], Angela Fessl[1,2], Thomas Klebel[1] and Nancy Pontika[3]

[1]Know-Center GmbH, Graz, Austria
[2]Open and Reproducible Research Group, Graz University of Technology, Inffeldgasse 13, 8010 Graz, Austria
[3]The Open University, Milton Keynes, UK

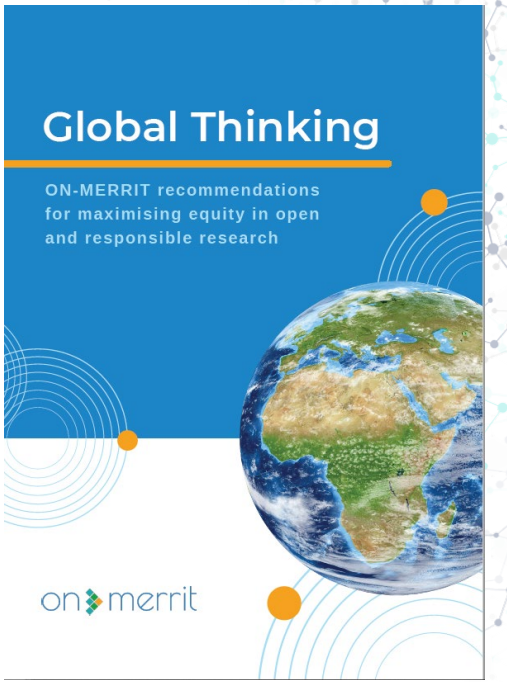
TR-H, 0000-0003-4470-7027; NLC, 0000-0002-6034-533X

Open Science holds the promise to make scientific endeavours

Ross-Hellauer et al. 2022. Dynamics of cumulative advantage and threats to equity in open science: a scoping review. *Royal Society Open Science*. https://doi.org/10.1098/rsos.211032

Avoiding unintended consequences

- Not all impacts will be positive, and trade-offs and unintended consequences are to be expected
- Need special attention on ways that variance in epistemic diversity alters what is desirable in terms of reproducibility
- Respect differences in levels of advancement in dealing with these issues across these contexts
- Ensure that policies reflect this diversity, and harness openness of infrastructures, tools, services, and training to move as a global community



C.f., Cole, Reichmann, Ross-Hellauer. (2022). Global Thinking. ON-MERRIT recommendations for maximising equity in open and responsible research. https://doi.org/10.5281/zenodo.6276753

In TIER2 …

- Developing open, collaborative solutions
- Plan with sister projects for working group on DEI issues
- Open Call (recently closed) for small awards to support foundation of RNs in “widening participation” countries https://tier2-project.eu/open-call

TIER2 Award: Establish a Reproducibility Network in your country

TIER2 aims to foster the creation of three new Reproducibility Networks (RNs) in “Widening participation” countries. Three selected consortia will receive an award of 5,000 Euros to organize an initial meeting to establish a Reproducibility Network in their countries. The aim of Reproducibility Networks is to foster rigorous research practices and increase the trustworthiness of scientific work.

Selection will be based on the feasibility, scope, and sustainability of the proposal.

Recap

Priorities for Reproducibility Reform

1. Frame reproducibility as a reformation

Ditch the 'crisis' narrative and reframe debate to emphasize the opportunities possible through a broad holistic movement towards reproducibility reformation

2. Centre epistemic diversity

Better understand the meanings, implications and conditions of/for reproducibility across disciplinary, methodological, geographic and stakeholder contexts

3. Systematize the evidence

Foster (systematic) experimentation across, between and within contexts to generate comparative findings, inform/cross-pollinate interventions, identify trade-offs

4. Collaborate to boost capacity

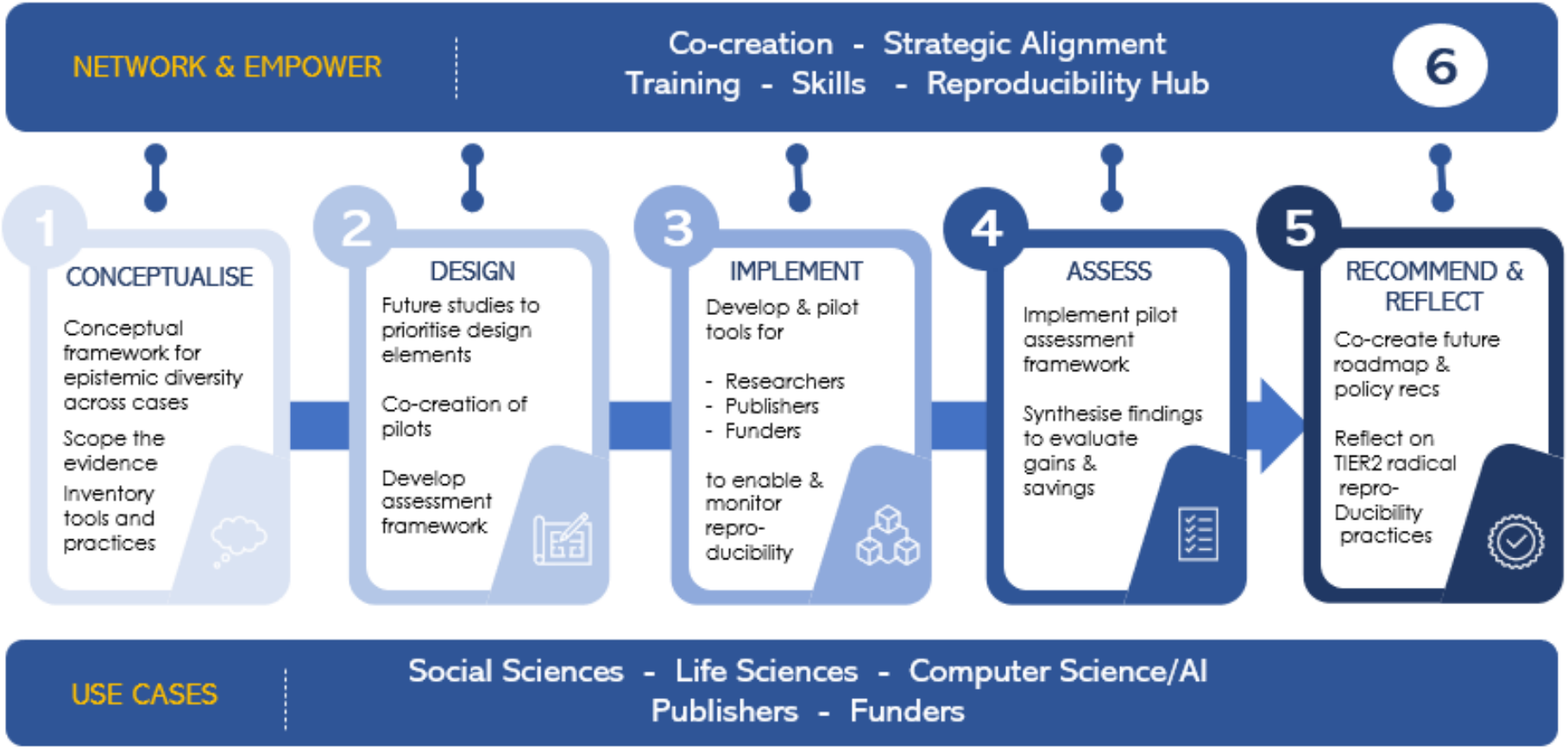
Network existing initiatives across dimensions of research to build capacities and harness network effects, especially by empowering the Reproducibility Networks

5. Minimize unintended consequences

Be alert to possible negative impacts and trade-offs, and work to maximize equitable transition, especially through global dialogue and open infrastructures/services

TIER

TIER2 methodological steps



Website: https://tier2-project.eu/
Social media: https://twitter.com/TIER2Project

TIER 2

Thank you!

My contact details

tross@know-center.at
https://orrg.eu/
https://twitter.com/tonyR_H
https://mstdn.social/@tonyRH