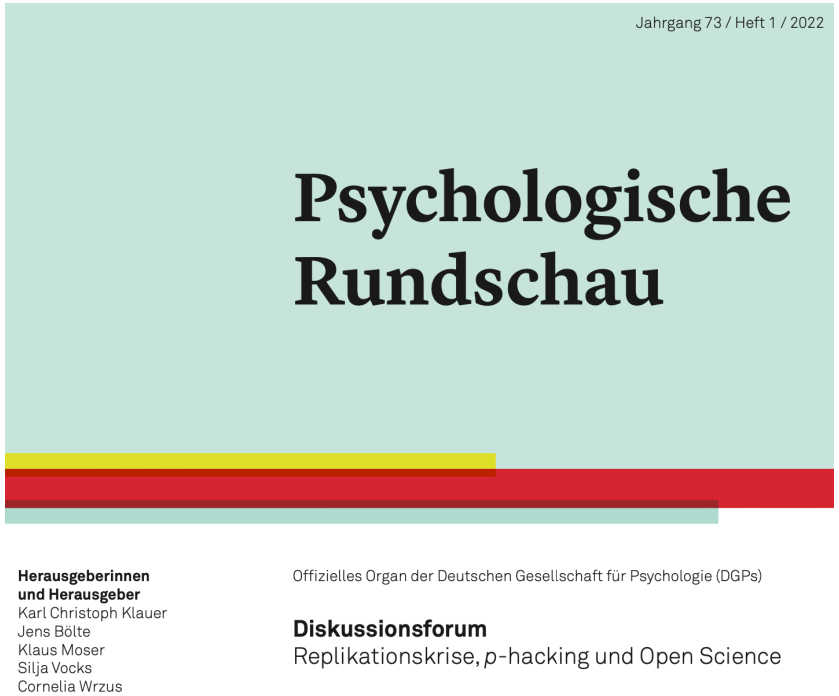
How to Teach Open Science Principles in the Undergraduate Curriculum

The Hagen Cumulative Science Project

Department Psychologie / Sozialpsychologie | Humanwissenschaftliche Fakultät | Dr. Marc Jekel | 10.10.22

Plan for today

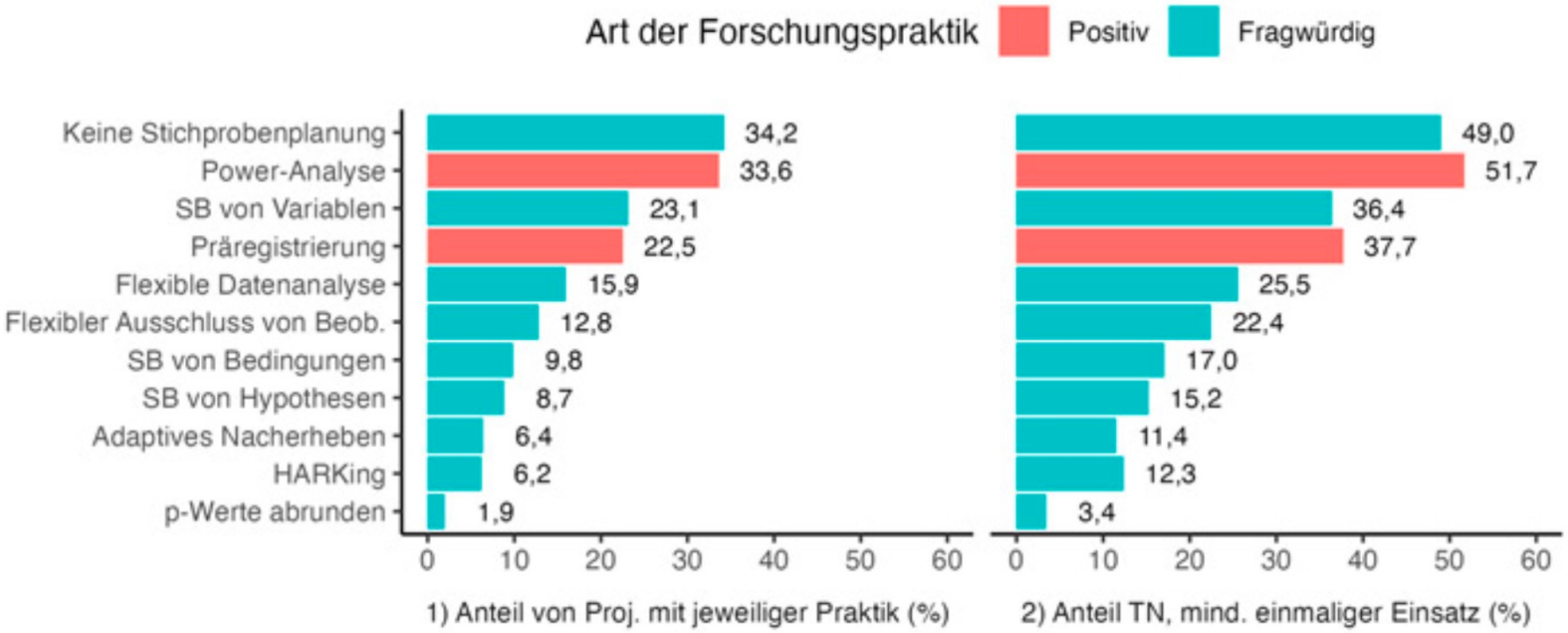
1. Open science in the curriculum
2. Hagen Cumulative Science Project
3. Novel approaches to replication research



Open Science in the Curriculum

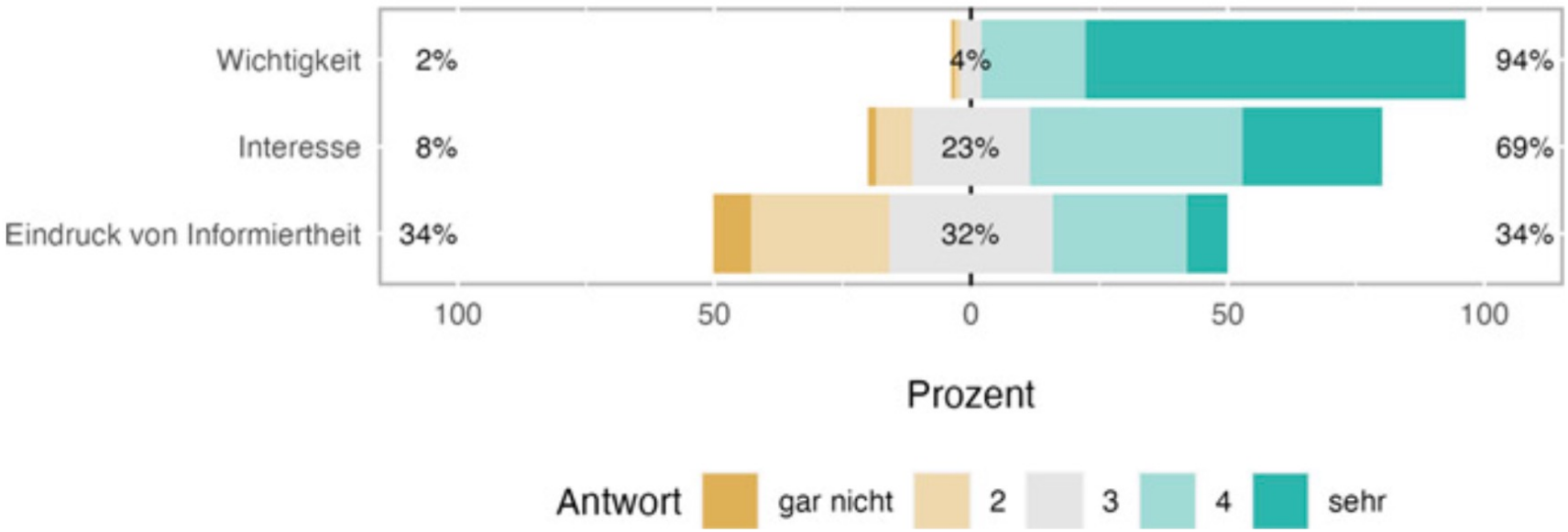
Data on the Current Status of Open Science in the Psychology Curriculum in Germany

n > 1100,
diverse sample



Brachem, J., Frank, M., Kvetnaya, T., Schramm, L. F. F., & Volz, L. (2022). Replikationskrise, *p*-hacking und Open Science: Eine Umfrage zu fragwürdigen Forschungspraktiken in studentischen Projekten und Impulse für die Lehre. *Psychologische Rundschau*, *73*(1), 1–17. https://doi.org/10.1026/0033-3042/a000562

Data on the Current Status of Open Science in the Psychology Curriculum in Germany



Additional results: Negative relation between importance and QRP and impression of informdness and QRP but not (!) interest in open science and QRP

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Interim Conclusion

- About 50% of students did a power analysis
- About 40% of students did at least one pre-registration

  It‘s a good start but we can do better…

Source: https://flic.kr/p/adJQM8

Report

PSYCHOLOGY LEARNING & TEACHING

How to Teach Open Science Principles in the Undergraduate Curriculum—The Hagen Cumulative Science Project

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Hagen Cumulative Science Project

Hagen Cumulative Science Project

JUDGMENT AND DECISION MAKING

VOLUME 14, NUMBER 2, MARCH 2019

CONTENTS

The title is linked to the pdf version, which should be used for printing, quotation, or citation. The html version is for convenience.

Direct replication of about 100 studies from the Journal *Judgment and Decision Making* (2012-2019)

Jekel, M., Fiedler, S., Allstadt Torras, R., Mischkowski, D., Dorrough, A. R., & Glöckner, A. (2020). How to teach open science principles in the undergraduate curriculum—The Hagen Cumulative Science Project. *Psychology Learning & Teaching*, *19*(1), 91–106. https://doi.org/10.1177/1475725719868149

Why direct Replications in Theses?

- Original research gives orientation and structure
- Knowledge about statistical methods gets activated by a reanalysis of the original data
- Students contribute to research in a meaningful way
- Students internalize open science values

Step 1a: Identify Feasable Studies

- Empirical study
- Statistically significant result in final study
- Statistical methods that BA and MA students can handle
- No special target populations
- No special equipment

→Set of studies may not be representative

→Define reference population

Step 1b: Match Student with Studies

Students receive an original study that they will replicate

→Preferences about topics vary

→Match student according to their prefrences

Step 1c: Select Central Finding

Students identify central finding in the final study

→Study includes more than one central finding

→Consult original authors or pick randomly

→Central finding is not statistically significant

→Select the second-to-last study

Step 2: Reanalyze Original Data

- Students gain a better understanding of the study
- Students experience when data is not well documented
- Students are prepared for the replication analysis

→Original data is unavailable

→Instructor may generate a fictious data-set

→Results deviate from reported results

→Consult original authors

Step 3: Do a Power Analysis

Students estimate sample size for sufficient statistical power based on original effect size or minimal effect size

→ N to big

→ Instructors discuss a compromise power-analysis

→ Original effects are likely overestimated

→ Students use the 95% lower bound of the CI for the effect size

→ Power analysis not easily possible for the model

→ Instructor may do a bootstrapping analysis based on the original data.

Step 4: Implement the Study

Students implement the study (i.e., Qualtrics, offline material)

→Original materials are unavailable

→Materials can be recreated based on the desciption in the article

→Study materials might not fit the culture

→Materials can be adapted and adaptions can be tested

Step 5: Preregister the Study

Students prepare a pre-data report and upload study materials in (e.g.) Open Science Framework. Original authors are informed about the replication attempt and are invited to comment.

→Copyright might restrict posting of material

→Material can be described in the pre-data report and the original source can be linked

→Original authors may not respond

→Set a deadline in the first-contact email

Step 6: Collect Data

Students collect the targeted sampe size

→Students are unable to collect the targeted sample size in time

→A deadline for data collection is set before starting data collection

Step 7: Analyze Data

Students analyze the data to test the replicability of the original effect

Step 8: Document Study

- Students document data and analysis scripts on (e.g.) Open Science Framework after careful reexamination from instructors
- Results are described in a post-data addendum
- Original authors are informed about the outcome of the replication attempt

→ Constraints due to anonymization and ethical data sharing must be carefully considered

→ Check with local data security official and national guidelines and, if necessary, share reduced data set (e.g., without gender or age variables)

Step 9: Prepare Thesis

Students write their thesis based on the documented results

Step 10: Combine Results

Instructors combine results from multiple replications in a meta-analysis

→Quality of data and analysis documentation is heterogeneous

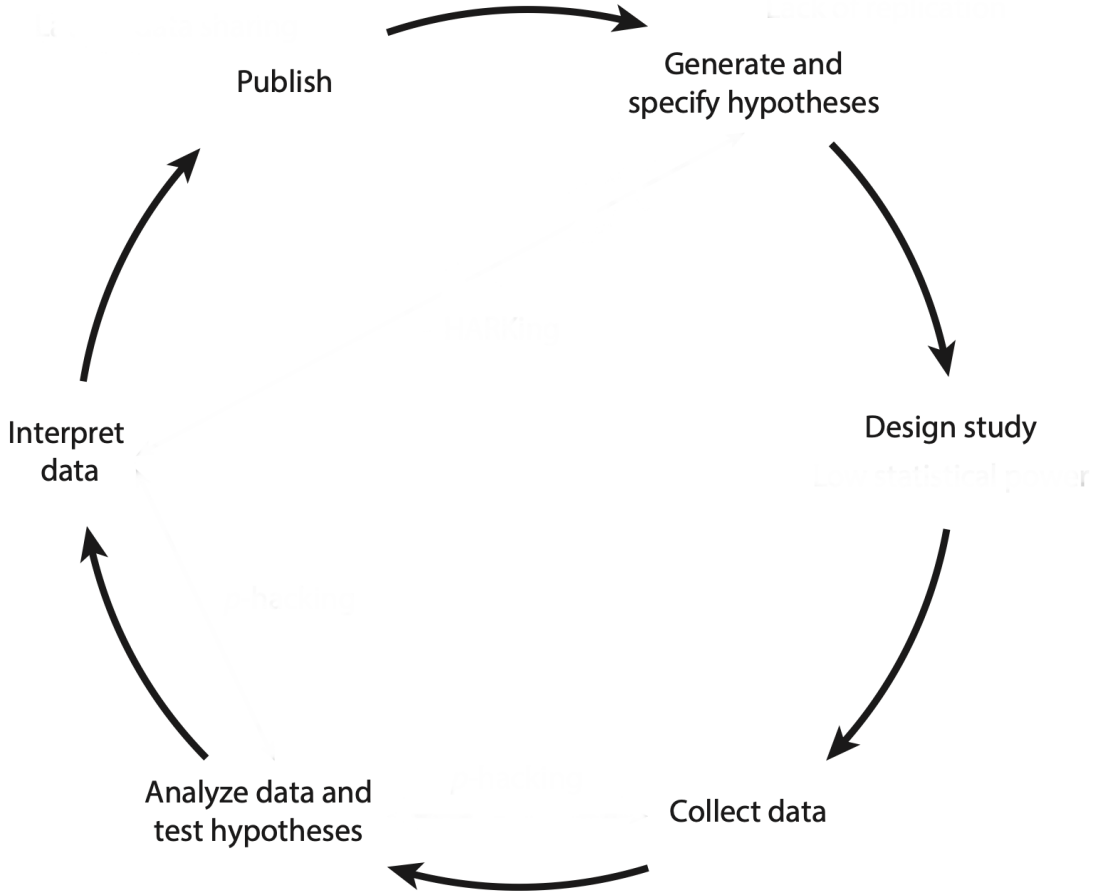
→Instructors provide a standardized form for documentation and inspect student documents promptly after submission to allow time for contacting students for potential queries

Ideas for adaptions

- Approach can be applied in a 2-semester practical
- Single aspects can be trained in methods classes
- Master students need to include a moderator of the effect in their thesis

Interim Conclusion

- The ten steps give students and instructors a structure
- Students apply / combine Open Science standards
- Students experience the full research cycle



Win-win situation for students, instructors, and the research community

Adapted from Chambers, C. (2017). *The seven deadly sins of psychology: A manifesto for reforming the culture of scientific practice*. Princeton University Press.

Interim Conclusion: What Students Learn

1. Evaluating research questions critically by understanding an original study in detail to prepare its replication
2. Reflecting whether the applied methods of the original study allow to answer the posed research question
3. Obtaining firsthand experience concerning what it takes to conduct and document an empirical study in such a way that other researchers can potentially replicate it

Novel Approaches

Prime Reason for Replication Success

- Statistical conclusion validity
  - QRPs, alpha-error, publication bias, beta-error

Ioannidis, J. P. A. (2005). Why most published research findings are false. *PLoS Medicine*, *2*(8), e124. https://doi.org/10.1371/journal.pmed.0020124

John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the prevalence of questionable research practices with incentives for truth telling. *Psychological Science*, *23*(5), 524–532. https://doi.org/10.1177/0956797611430953

Nelson, L. D., Simmons, J., & Simonsohn, U. (2018). Psychology's renaissance. *Annual Review of Psychology*, *69*(1), 511–534. https://doi.org/10.1146/annurev-psych-122216-011836

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, *86*(3), 638–641. https://doi.org/10.1037/0033-2909.86.3.638

Simonsohn, U., Nelson, L. D., & Simmons, J. P. (2014). P-curve: A key to the file-drawer. *Journal of Experimental Psychology: General*, *143*(2), 534–547. https://doi.org/10.1037/a0033242

Understudied Reasons for Replication Success

- Internal validity
  - Conditional dropouts
    (broader topic: e.g., theory development: Special Issue PPS 2021)
- Construct validity
  - Measurement invariance
    (broader topic: e.g., invalidity of measures: Hussey & Hughes, 2020)
- External validity
  - Cultural change and sensitivity
    (broader topic: e.g., hidden moderators: Zwaan et al., 2018)

Fabrigar, L. R., & Wegener, D. T. (2016). Conceptualizing and evaluating the replication of research results. *Journal of Experimental Social Psychology*, *66*, 68–80. https://doi.org/10.1016/j.jesp.2015.07.009
Fabrigar, L. R., Wegener, D. T., & Petty, R. E. (2020). A validity-based framework for understanding replication in psychology. *Personality and Social Psychology Review*, *24*(4), 316–344. https://doi.org/10.1177/1088868320931366

Conceptual Replication Research

- Construct validity (Operationalizations)
  - Different operationalization of independent variable
  - Different operationalization of dependent variable
  - Different operationalizations of moderators and mediators
- External validity (Moderators)
  - Different age groups
  - Different cultures
  - Different contexts
- Internal validity (Mediators)
  - Testing competing causal chains of a iV/dV relation
  - Testing competing functional relations between variables

Steiner, P. M., Wong, V. C., & Anglin, K. (2019). A causal replication framework for designing and assessing replication efforts. *Zeitschrift Für Psychologie*, *227*(4), 280–292. https://doi.org/10.1027/2151-2604/a000385

Lessons learned and lessons that could be learned…

- Statistical conclusion validity
  - Bigger N, power-analysis, pre-data reports

- Internal validity
  - Manipulation checks, theory (mediators, function between mediators)
- Construct validity
  - Vary operationalizations
- External validity
  - Vary characteristics of participants and/or material

Interim Discussion

Interdependent Study Design: Going beyond a single study

- How to construct a set of studies (research methodology)
- How to evaluate a set of studies (meta-science)

Teaching principled critical thinking

Conclusion

- Part I: Making the replication debate mainstream in teaching
- Part II: Including replication research in the curriculum
- Part III: Going beyond typical „replication research“

It‘s not only about learning how to do good research, it is also about understanding what good research looks like.