Framework for
Open and
Reproducible
Research Training

FORRT

FORRT sale's pitch

The enemy	Why now?	The promised land	Obstacles	How?
Bad Science	**Credibility Crisis**	**Scientific Nirvana**	**Research Training**	FORRT

Questionable
Research Practices (QRPs)
Q-Measurement-Ps
P-Hacking
Data Hogging
HARKing
Publication bias
Nefarious Incentives
Underpowered studies

The Enemy

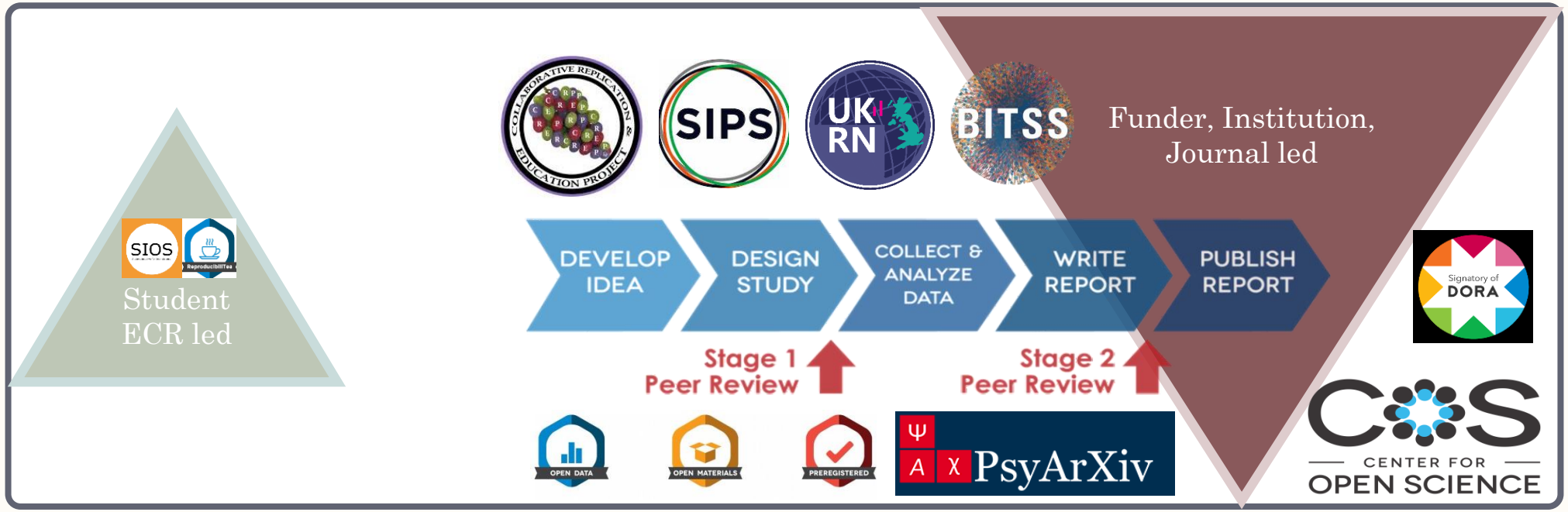
Why now?

Reproducibility Crisis

Questionable Research

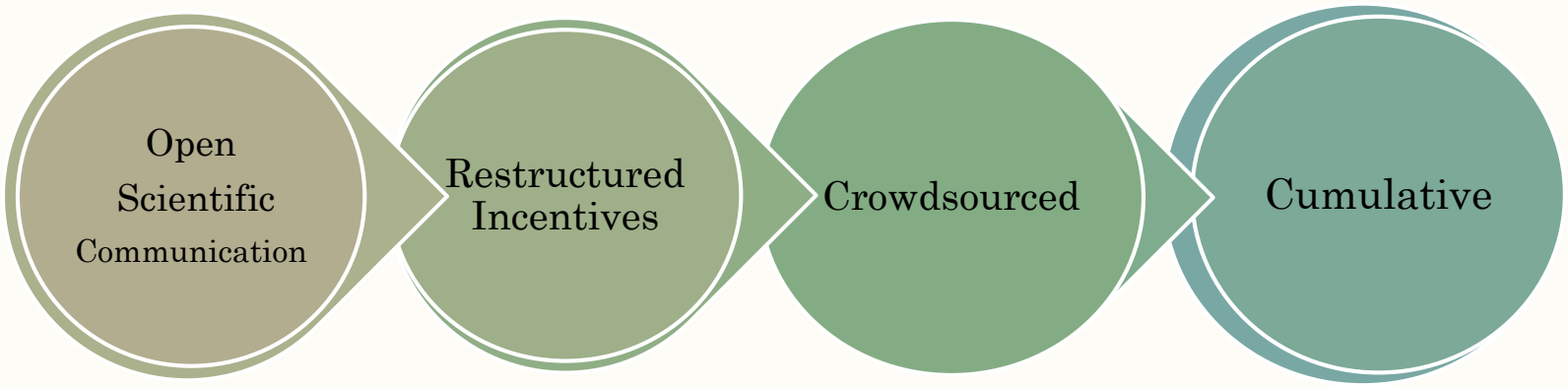
Misaligned Incentives

Re-evaluation



Why Now? Initiatives!

The Promised Land



Pillars of Academic Nirvana (Nosek et al., 2012, 2012, 2018)
The Psychological Science Accelerator (Chartier, 2016-Forever)
Becoming Cumulative Science (Mischel, 2009)

⚠ Obstacles ⚠

*Current **teaching** and*

***mentoring** practices*

Obstacles [1]

Teaching subject-matters without:

- probabilistic uncertainty
- research design
- Samples (type & quality)
- Measurements

Obstacles [2]

Thesis Supervision

- Questionable Research Practices (QRPs)
- Q-Measurement-Ps
- P-Hacking
- Data Hogging
- HARKing
- Publication bias
- Nefarious Incentives
- Underpowered studies

HOW?

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Question

*If science is a **process** of knowledge production, then **is science education** best **expressed** as teaching students **the process** or as teaching them the **knowledge itself**?*

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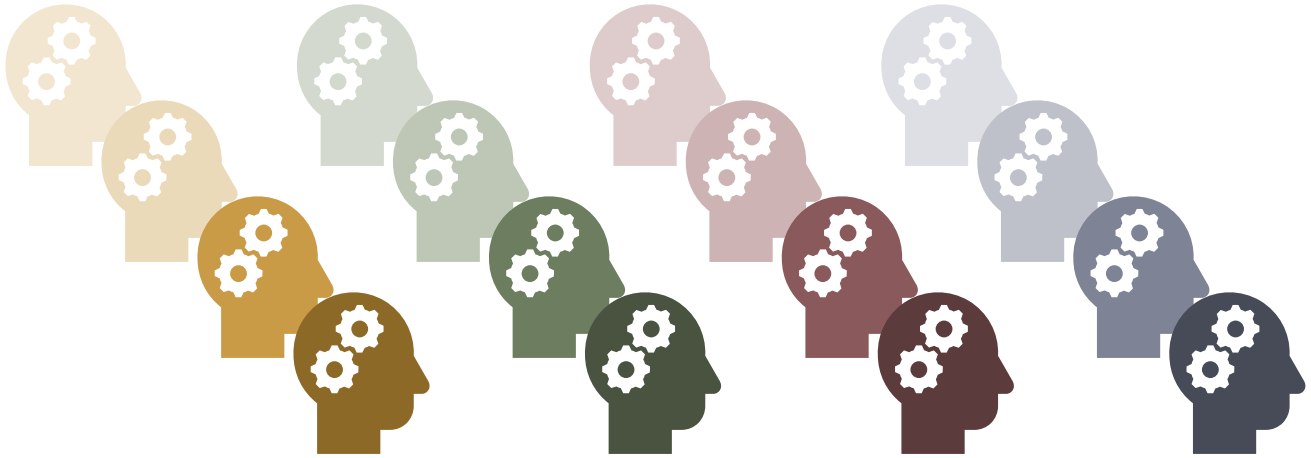
Possible Answer

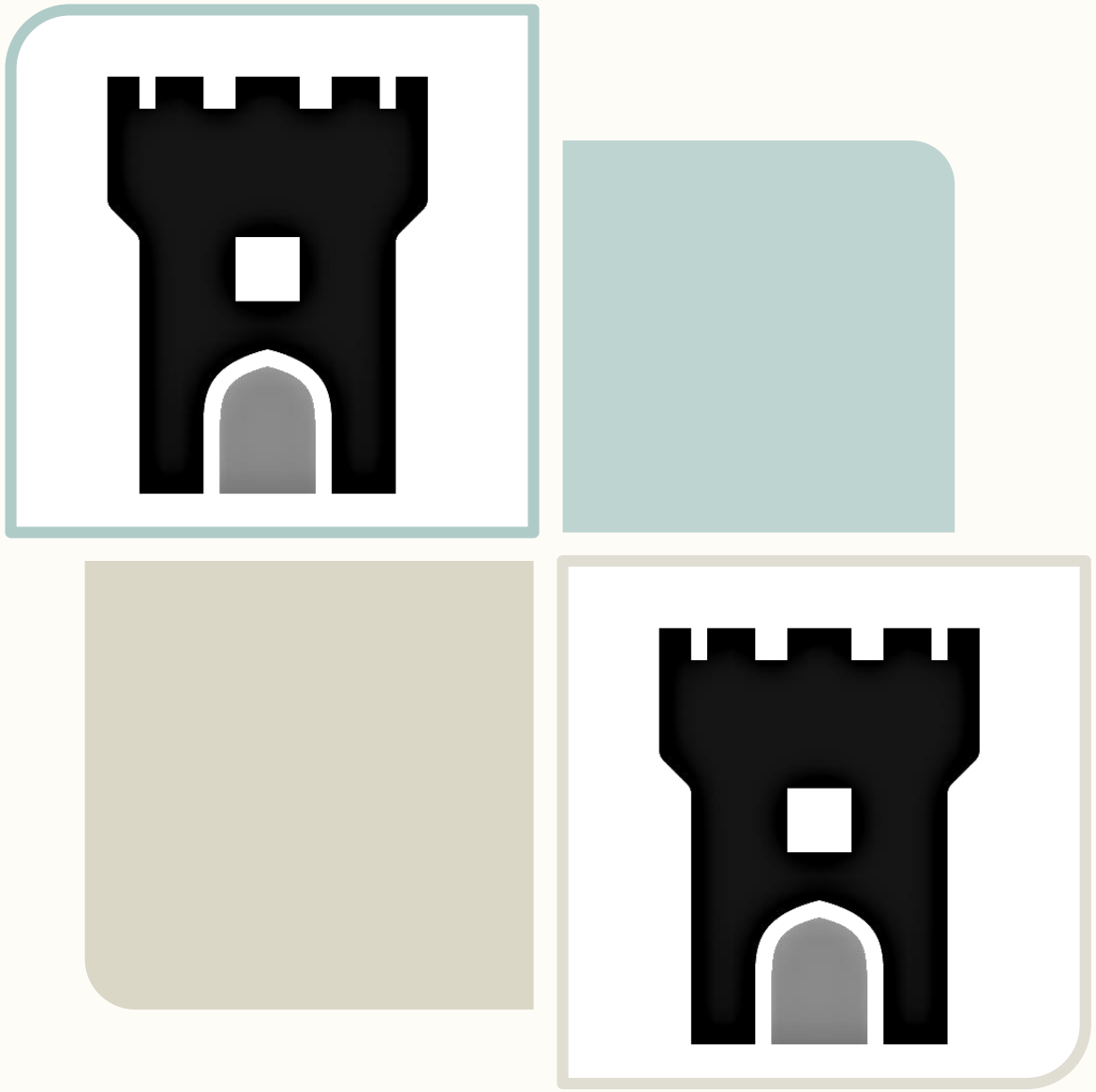
*Teaching students the **accumulated knowledge**, then we are **not** actually teaching them science. Rather, we are teaching them **science's products**, and indeed we are **misleading** them by substituting the teaching of scientific facts, **as if it were the teaching of science itself***

(Marks, 2009, p. 22)



FORRT:

Science education inevitably entails learning about *how* scientist learn *what* they know.



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KEY IDEAS

Purpose of Higher-ED

Epistemic Uncertainty

Ethics

Social Justice

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What is Purpose of Higher-Education?

Insofar ***higher education institutions*** *aim to prepare students for an increasingly* ***technological workforce*** *whose advances affect everyone's lives in ever shorter time spans,* ***its training ought to provide*** *the compulsory knowledge for* ***practical adjudication of scientific output****.*

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Emphasis on Epistemic Uncertainty

*Inasmuch as the **verity of quantitative scientific findings hinges** on probabilistic uncertainty, research design, measurements/instruments, sampling methods & representativeness, **we should communicate the facts of science relative to the process by which it was acquired.***

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The Ethics

Merging the teaching of substantive topics with open and reproducible means **to abide by principled teaching.** **e.g.,** to omit educating students about the replication crisis results in a **false sense of certainty**, which can be thought as **misleading**, if not **unethical**.

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The ***why*** of **open** *in teaching/mentoring*

Social Justice[1]

Maximize every student's likelihood of present and future engagement with resources, facilitate the acquisition of knowledge **and bolster opportunities that would otherwise be inaccessible to disadvantaged individuals**.

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The ***why*** of **open** in *teaching/mentoring*

Social Justice[2]

In science, **wealthy and elite-educated** individuals are **over-represented**, as are **males, whites, and citizens of western industrialized** rich countries.

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The ***why*** of **open** in *teaching / mentoring*

Social Justice[3]

The current model of scientific production and teaching practices **reproduces global inequalities**. And as science is built on the same foundations of society itself, **it inherits** many of its **systematic barriers** hindering the success of traditionally **marginalized groups**.

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The ***why*** of **open** in *teaching/mentoring*

Social Justice[4]

To help mitigate the **detrimental effects** in the **access, learning and production of scientific content**, it is paramount to create the conditions for knowledge to become **a public good, accessible to all members of society.**

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Summary

Teaching and **Mentoring**
of reproducible and open research practices
is the **clearest indicator** of the degree to which
institutions and/or departments
embody principles of credible science.

Consequences of FORRT

Future Consumers of science

Future scholars

Collaborative Crowdsourced Citizen

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FORRT *Educational Nexus*

- **Curated**
  - *Reproducibility and replicability knowledge*
  - *Conceptual and statistical knowledge*
  - *Reproducible analyses*
  - *Preregistration*
  - *Open data and materials*
  - *Replication research*
- **Crowdsourced**
  - *As above*

FORRT *Assessment*

6 core principles

- Reproducibility and replicability knowledge
- Conceptual and statistical knowledge
- Reproducible analyses
- Preregistration
- Open data and materials
- Replication research

I. Reproducibility Crisis and Credibility Revolution		II. Conceptual and Statistical Knowledge		III. Reproducible analyses		IV. Open data and materials		V. Preregistration		VI. Replication research	
Attainment of a grounding in the motivations and theoretical underpinnings of reproducible and open research. Integration with field specific content (i.e., or grounded in the history of replicability)		*Enacting this principle indicates that students attain a grounding in fundamental statistics, measurement, and its implications.*		*Reproducible analyses allow the checking of analytic pipelines and facilitate error correction. Enacting this principle requires students to move towards transparent and scripted analysis practices*		*Enacting this principle indicates that students have attained a grounding in open data and materials in both; using and sharing*		*Preregistration entails laying out a complete methodology and analysis before a study has been undertaken. This facilitates transparency and removes several potential QRPs.*		*Replication research takes a variety of forms, each with a different purpose and contribution. Reproducible science requires replication research.*	
i.	Reproducibility crisis and credibility revolution.	*i.*	The logic of null hypothesis testing, p-values, Type I and II errors (and when and why they might happen).	*i.*	Strengths of reproducible pipelines.	*i.*	Knowledge of traditional publication models. Open access publishing, preprints	*i.*	Purpose of preregistration - distinguishing exploratory and confirmatory analyses, transparency measures	*i.*	Purposes of replication attempts - what is a 'failed' replication?
ii.	Exploratory and confirmatory analyses.	*ii.*	Limitations and benefits of NHST, Bayesian and Likelihood approaches.	*ii.*	Scripted analyses compared with GUI.	*ii.*	Reasons to share; for science, and for one's own practices	*ii.*	Preregistration and registered reports - strengths and differences	*ii.*	Large scale replication attempts
iii.	Questionable research practices (its 'theory'), and prevalence.	*iii.*	Effect sizes, Statistical power, Confidence Intervals.	*iii.*	Data wrangling	*iii.*	Repositories; e.g. OSF, FigShare, GitHub	*iii.*	When can you preregister? Can you pre-register secondary data?	*iii.*	Distinguishing conceptual and direct replications
iv.	Proposed improvement science initiatives on statistics, measurement, teaching, data sharing, code sharing, pre-registration, replication.	*iv.*	Research Design, Sample Methods, and its implications for inferences.	*iv.*	Programming reproducible data analyses.	*iv.*	Accessing/sharing others data, code, and materials	*iv.*	Writing a preregistration.	*iv.*	Conducting replication studies; challenges, limitations, and comparisons with the original study
v.	Ongoing debates, (e.g. incentives for and against open science).	*v.*	Questionable research (QRPs) & measurement practices (QMPs).	*v.*	Open source and free software.	*v.*	Ethical considerations	*v.*	Comparing a preregistration to a final study manuscript.	*v.*	Registered Replication Reports
vi.	Ethical considerations for improved practices.	*vi.*	Understand the relationship between all of the above.	*vi.*	Tools to check yourself and others; statcheck, GRIM, and SPRITE	*vi.*	Examples and consequences of accessing un/open data	*vi.*	Conducting a preregistered study.	*vi.*	The politics of replicating famous studies

FORRT *Assessment*

Breadth describes how **widely** teaching is distributed

- **None.** Not yet enacted, minimal breadth, or no evidence
- **Some.** Opportunities for some.
- **Course requirement for all.**

Depth describes the **degree** to which students interact with the core:

- **None.** Not yet enacted, minimal depth, or no evidence
- **Knowledge.**
- **Practice.**
- **Application.**

FORRT *Assessment*

Depth:	None	Some	Required
None			
Knowledge		*As part of an **optional** course/module, or workshop, or lecture given;* attain knowledge of the importance of reproducible analyses, including data pipelines and scripting in R/Python/JASP/SPSS/etc.	*As part of a **required** (assessed) course/module/dissertation project;* attain knowledge of the importance of reproducible analyses, including data pipelines and scripting in R/Python/JASP/SPSS/etc.
Practice		*As part of an **optional** course/module, or workshop, or lecture given;* practice implementing reproducible data pipelines and analysis scripts with existing data.	*As part of a **required** (assessed) course/module/dissertation project;* practice implementing reproducible data pipelines and analysis scripts with existing data.
Application		*As part of an **optional** course/module, or workshop, or lecture given;* implement reproducible analytical pipelines in a research project.	*As part of a **required** (assessed) course/module/dissertation project;* implement reproducible analytical pipelines in a research project.

Where are we now?

FORRT needs you!

*https://osf.io/***bnh7p**

https://osf.io/**g29eu**

Thank you