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Citizen science and quality

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What is “science”? (I)

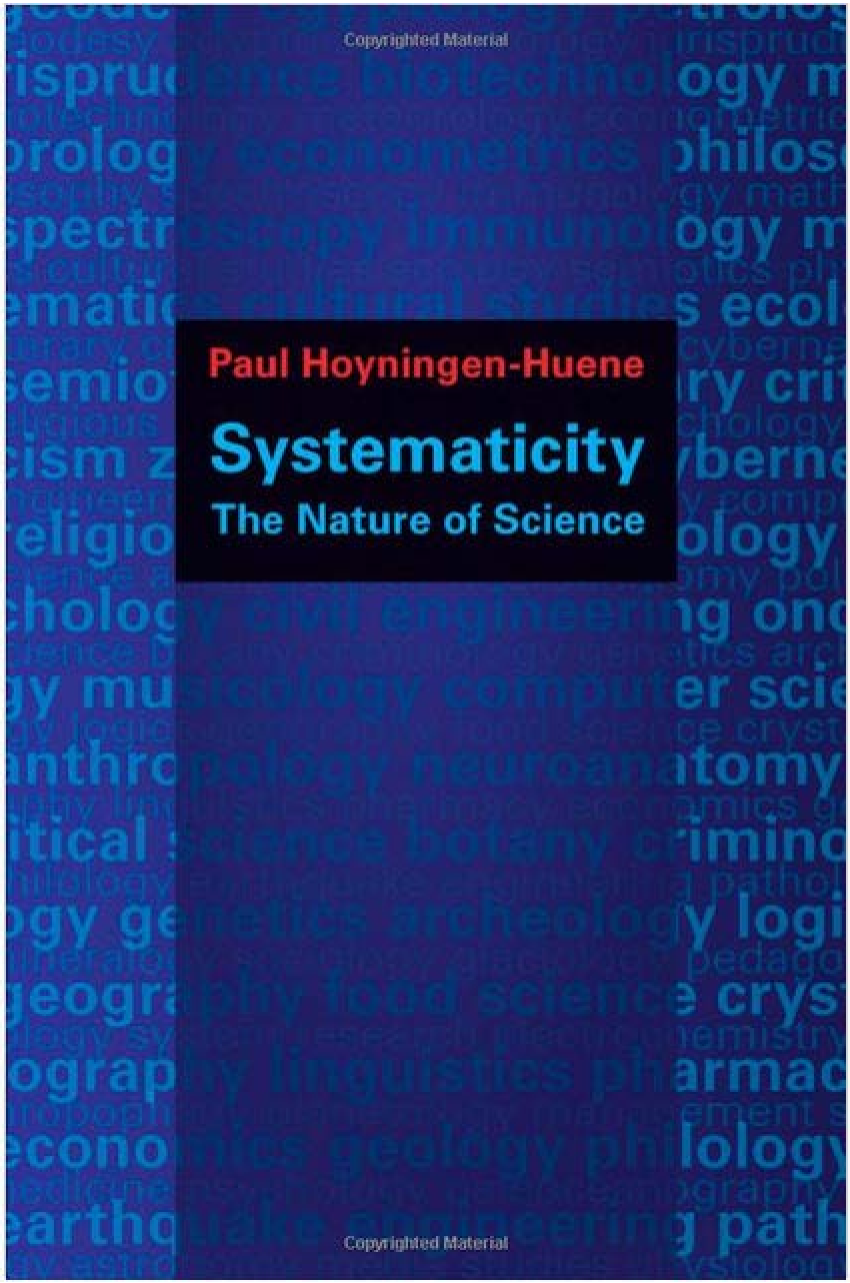
Styles of reasoning (Ian Hacking)

- characterise the way by which academic disciplines & practices arrive at scientific propositions
- determine what counts as rational or irrational, scientific or quasi-scientific, valid or invalid evidence, true or false.

Examples of styles:

- Postulation (mathematics)
- Experimental exploration
- Hypothetical construction of analogical models (‘knowing is making’)
- Ordering of variety by comparison and typology
- Statistical analysis of regularities of populations / probabilities.

(Crombie 1992, 1994, Hacking 1982, 1985, 1992, Kusch 2010)



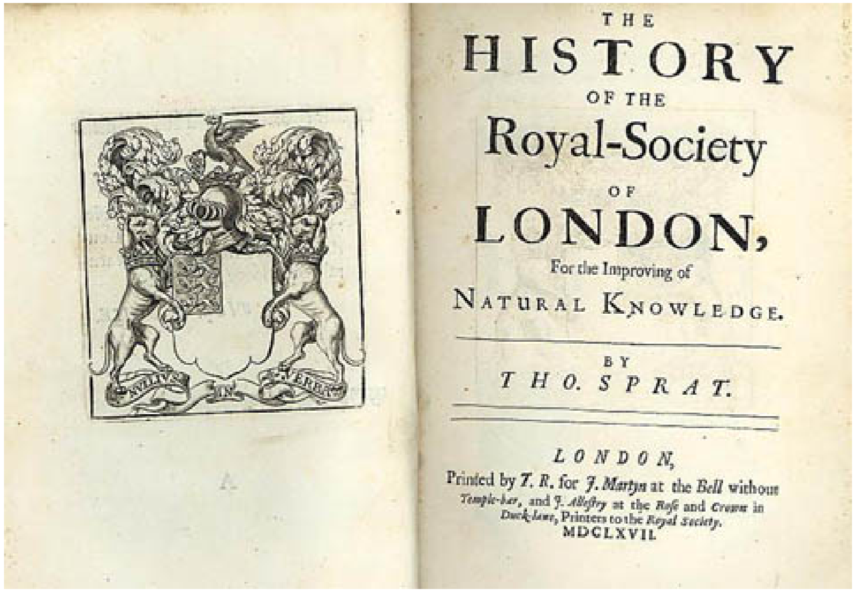
What is "science"? (II)

- Scientific knowledge is primarily distinguished from other forms of knowledge by being more systematic

(Hoyningen-Huene, 2013)

Four epochs of science

- Amateur science
- Professional science
- Industrial science
- Big Science



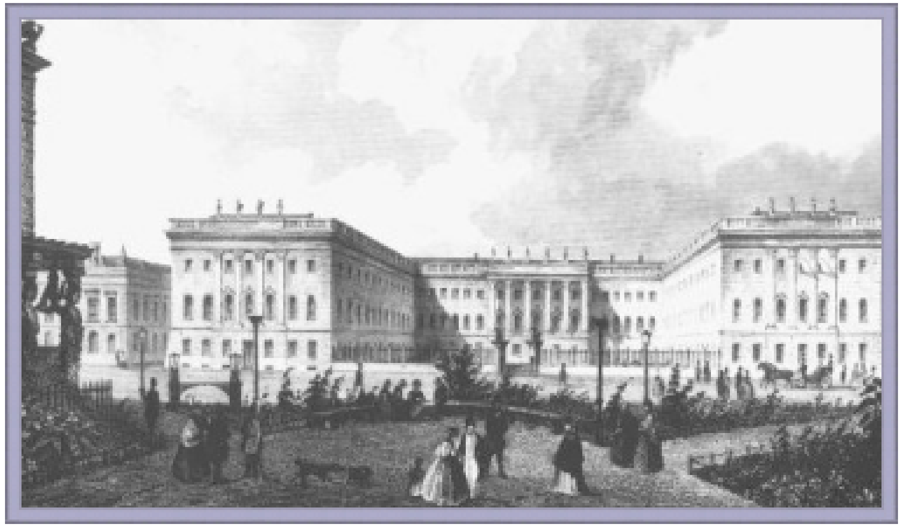
(Slide from Matthias Kaiser)

Amateur science

- Separated from universities
- Mainly as spare-time activity of men
- Independent income
- Partially sponsored by wealthy individuals with special interests
- Later: entertainment in French Salons

(Slide from Matthias Kaiser)

Professional science



- Starts with Humboldt University 1810 in Berlin
- Integration of education and research
- Education of public officials and administration
- Part of the larger culture

(Slide from Matthias Kaiser)

Industrialised science:

Pasteur und Metschnikow (stehend) mit Kindern, die von der Tollwut geheilt wurden

- End of 19th Century.
- Recognising the technological potential of science
- In line with the dominant view of progress
- Industrial institutes organised alongside universities
- Chemical industry; Kaiser Wilhelm Society (1911), etc.

(Slide from Matthias Kaiser)

Big Science

- Starts with 2nd World War
- Manhattan Project
- Collective enterprise towards common goal
- Management system
- Goal from outside science

(Slide from Matthias Kaiser)

Biotech, Nanotech, ICT, Converging Technologies, Synthetic Biology

nature

18 August 2015

Rise of the citizen scientist

From the oceans to the soil, technology is changing the part that amateurs can play in research. But this greater involvement raises concerns that must be addressed.

Science is not just for scientists these days. Going on a scuba-diving holiday this summer? Share the temperature data from your dive computer with researchers eager to plug holes in sparse records for inshore areas. Nervous about possible pollution from a nearby fracking project? Ease your concerns by helping to collect and analyse air samples as part of a monitoring project. Stuck at home as the rain pours down? Log on to the Internet and spend a couple of hours folding proteins and RNA to help university scientists work out how biology does it.

Citizen science has come a long way from the first distributed-computing projects that hoovered up spare processing power on home computers to perform calculations or search for alien signals. And it has progressed further still since the earliest public surveys of wildlife: it was way back in 1900 that the Audubon Society persuaded Americans to exchange their Christmas tradition of shooting birds for a more productive effort to count them instead.

Some professional scientists are sniffy about the role of amateurs, but as an increasing number of academic papers makes clear, the results can be valuable and can help both to generate data and to inform policy.

A paper in *Geoderma* entitled 'Can citizen science assist digital soil mapping?' (D. G. Rossiter *et al. Geoderma* **259–260,** 71–80; 2015) makes the case that, yes, non-specialists can help expert soil scientists to track quality, properties and types of soil. It goes further: these amateur soil researchers should be recruited to help with existing and future national surveys. Civil engineers and construction workers routinely view the subsoil, and digging foundations for buildings and trenches for pipelines offers a unique look at the spatial variability of different layers. An army of geocachers — twenty-first-century treasure hunters — visit harsh terrain and difficult-to-access places, and could collect soil data. And they routinely use satellite navigation to record their journeys.

Technology can make scientists of us all. Data churned out by the rapid spread of consumer gadgets equipped with satellite navigation, cameras and a suite of other sensors, and the ease of sharing the results digitally, are driving the boom in citizen science. Volunteers can already identify whale songs from recordings, report litter and invasive species, and send in the skeletons of fish they have caught and consumed. But there is more to being a scientist, of course, than collecting and sharing data — especially if the results are to be used to help determine policy.

Critics have raised concerns about data quality, and some studies do find that volunteers are less able to identify plant species than are academics and land managers. And there are issues around how to reward and recognize the contribution of volunteers, and around ensuring that data are shared or kept confidential as appropriate. But these problems seem relatively simple to address — not least because they reflect points — from authorship to data quality and access — that the professional scientific community is already wrestling with.

More troubling, perhaps, is the potential for conflicts of interest. One reason that some citizen scientists volunteer is to advance their political objectives. Opponents of fracking, for example, might help to track possible pollution because they want to gather evidence of harmful effects. When Australian scientists asked people who had volunteered to monitor koala populations how the animals should be managed, they found that the citizen scientists had strong views on protection that did not reflect broader public opinion.

Scientists and funders are right to encourage the shift from passive citizen science — number crunching — to more-active roles, including sample collection. But as increased scrutiny falls on the reliability of the work of professional scientists, full transparency about the motives and ambitions of amateurs is essential. ■

- It may be argued that citizens lack theoretical knowledge and are biased by self-interest
- It can equally well be argued that academic scientist lack practical knowledge and have their own unselfconscious forms of bias

Roles of citizens in science

- (Co-) definer of the problems to be addressed (influence or set the research agenda)
- Producer of original knowledge
- Source of local / traditional knowledge
- Extended peer review: engage in quality control of science done by others (for instance: review of assumptions)

Local knowledge

- knowledge of local conditions, which may determine which data are strong and relevant,
- anecdotes
- informal surveys
- official information published by unofficial means
- investigative journalism
- can help to diffuse the policy problems

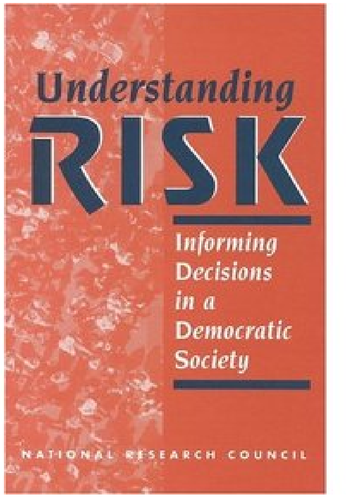
local knowledge / Indigenous Knowledge–

- Knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities. (Warren, 1991)
- Indigenous knowledge is used synonymously with ‘traditional’ and ‘local’ knowledge to differentiate the knowledge developed by a community from the international knowledge systems sometimes called ‘’Western’ system, generated through universities, government research centres and private industry. IK refers to the knowledge of indigenous peoples as well as any other defined community. (Warren, 1992)

“Knowledge used for policy-making and public debate should not only be excellent from a scientific point of view; it also needs to be ‘socially robust’, responding to policy, social, economic needs or concerns. This involves expertise beyond traditional and professional ‘peer’ community to include those with practical or other knowledge about the issue at hand.”

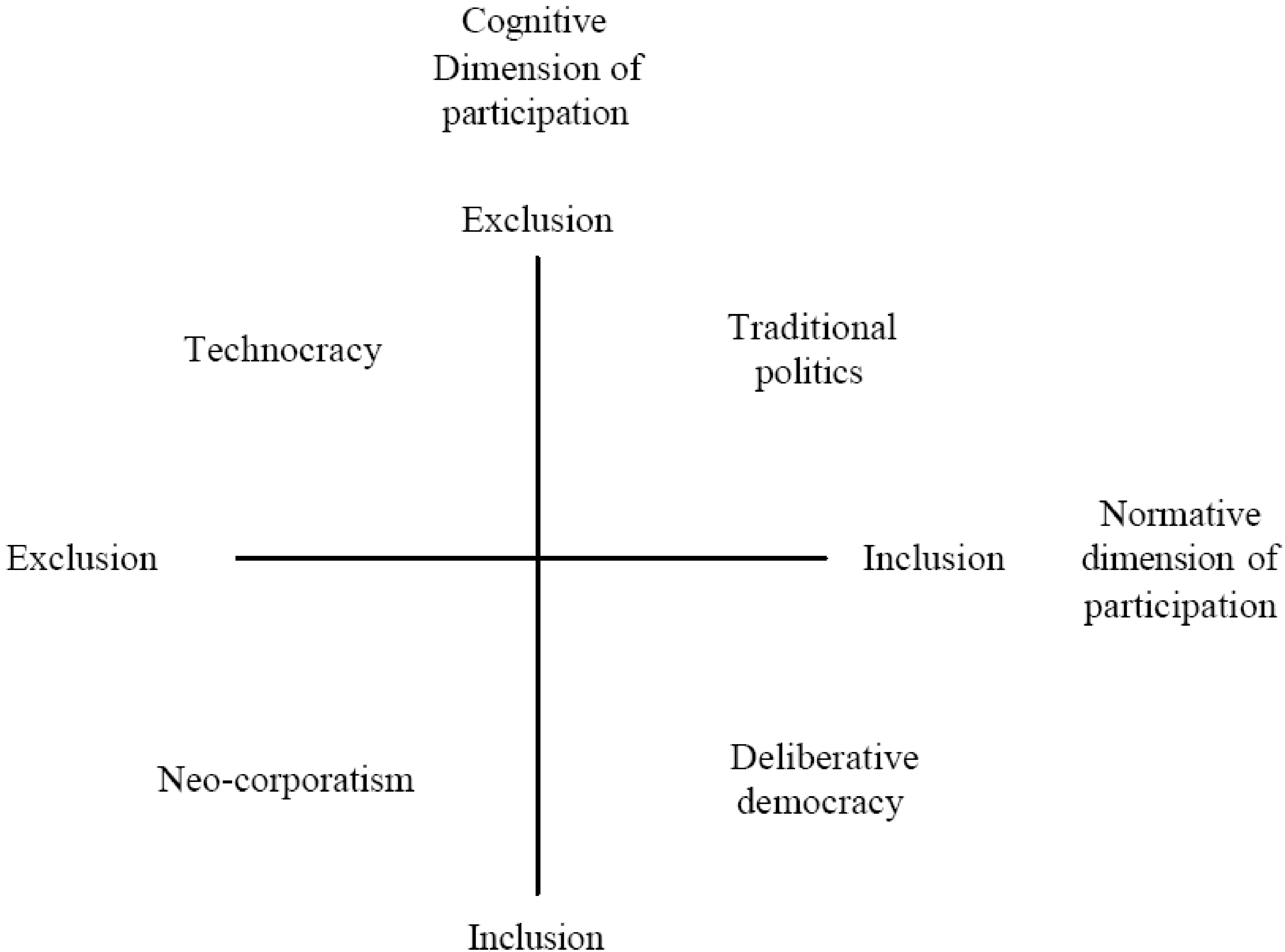
EU White Paper on Governance, Liberatore, A. rapporteur, 2001.

Incentives for participatory risk assessment



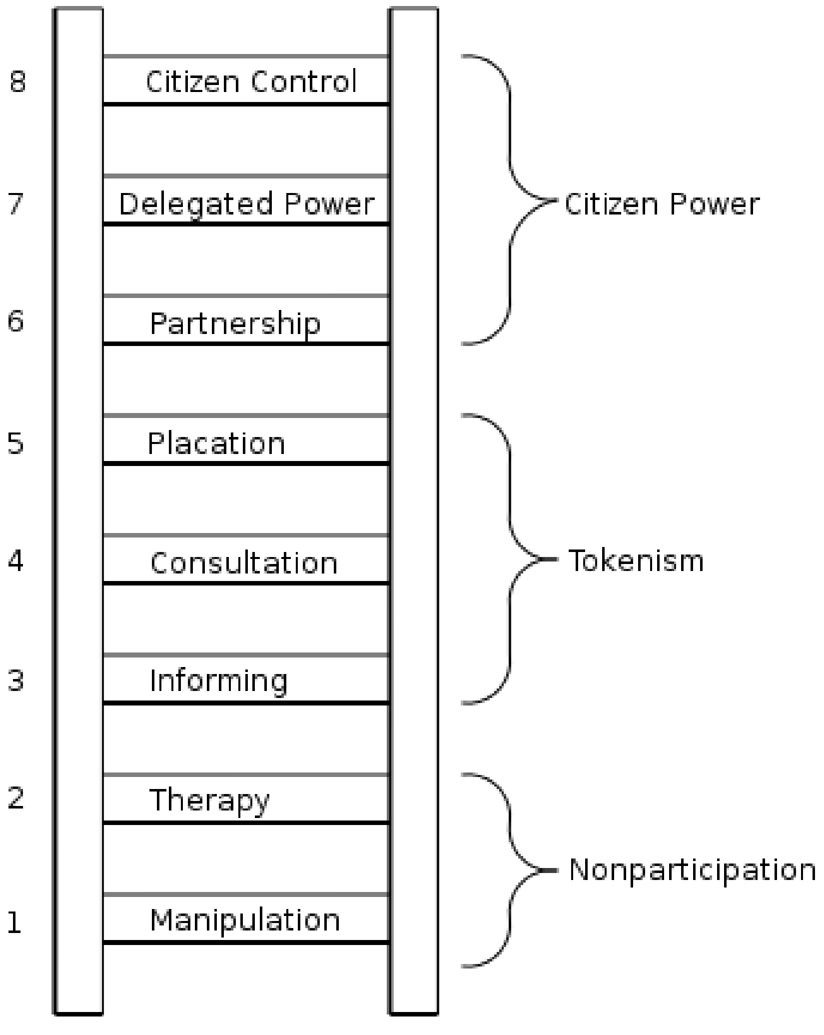
- Instrumental
  - decrease conflict/increase acceptance of or trust in the science
- Normative
  - process should be legitimate/ democracy
- Substantive
  - relevant wisdom is not limited to scientific specialists and public officials
  - Bounded rationality
  - Increase quality

(Stern & Fineberg, ***Understanding Risk, Informing Decisions in a Democratic Society***, 1996)



Models of participatory policy-making (Pellizzoni, 2001)

A Ladder of Citizen Participation, Arnstein, 1969



1 Manipulation and 2 Therapy. non participative, cure or educate the participants. achieve public support by PR.
3 Informing. one way flow of information
4 Consultation. attitude surveys, neighbourhood meetings and public enquiries. Window dressing ritual
5 Placation. Allows citizens to advise but retains for power holders the right to judge the legitimacy or feasibility of the advice.
6 Partnership. Power is redistributed through negotiation between citizens and power holders. Shared decision-making responsibilities.
7 Delegated power to make decisions. Public now has the power to assure accountability.
8 Citizen Control. Participants handle the entire job of planning, policy making and managing a programme.

http://lithgow-schmidt.dk/sherry-arnstein/ladder-of-citizen-participation.html

POLICYFORUM

CITIZEN SCIENCE

Next Steps for Citizen Science

Strategic investments and coordination are needed for citizen science to reach its full potential.

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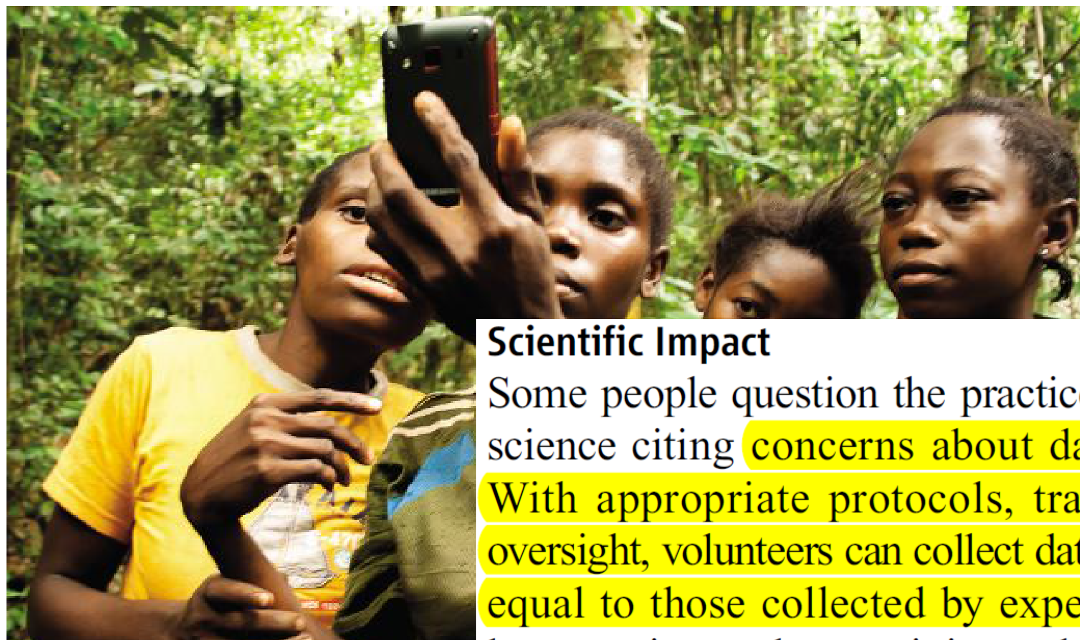
Around the globe, thousands of research projects are engaging millions of individuals—many of whom are not trained as scientists—in collecting, categorizing, transcribing, or analyzing scientific data. These projects, known as citizen science, cover a breadth of topics from microbiomes to native bees to water quality to galaxies. Most projects obtain or manage scientific information at scales or resolutions unattainable by individual researchers or research teams, whether enrolling thousands of individuals collecting data across several continents, enlisting small armies of participants in categorizing vast quantities of online data, or organizing small groups of volunteers to tackle local problems.

Despite the wealth of information emerging from citizen science projects, the practice is not universally accepted as a valid method of scientific investigation. Scientific papers presenting volunteer-collected data some-



Training for data-gathering. Women from Kc part of the Extreme Citizen Science (ExCiteS) Ir

Scientific Impact

Some people question the practice of citizen science citing concerns about data quality. With appropriate protocols, training, and oversight, volunteers can collect data of quality equal to those collected by experts (*3*). For large projects where training volunteers and assessing their skills can be challenging, new statistical and high-performance computing tools have addressed data-quality issues such as sampling bias, detection, measurement error, identification, and spatial clustering (*4*, *5*).

http://dx.doi.org/10.1126/science.1251554

Which of these tools has the highest quality

Q1:  or 

Q2: Citizen science or Academic science

If you need a tool to put a nail in the wall, which tool has the highest quality?

What is quality?

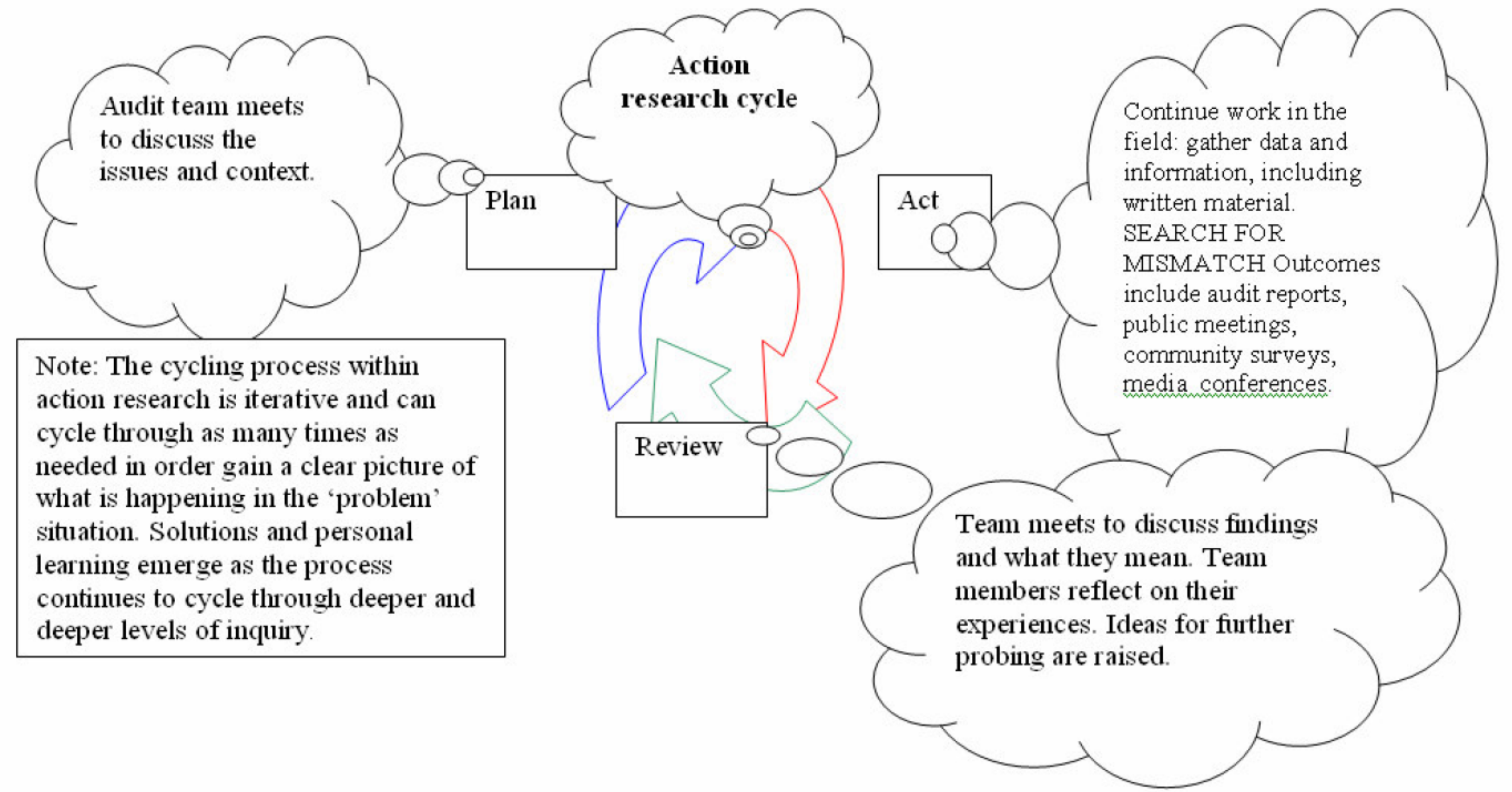
- British Standard Institution (1979) and the ISO 8402 (ISO 1986) define quality as
  "The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs."

- Plato: "the quality of something is measured by its ability of reaching its goal"

- FITNESS for
  - Use
  - Purpose
  - **Function !**

(Slide adapted from Serafin Corral)

Community Based Auditing



Relationships among the processes within CBA methodology (source: Tattersall, 2007, 2008).

Why Most Published Research Findings Are False (Ioannidis, 2005)

There is increasing concern that most current published research findings are false. **The probability that a research claim is true may depend on study power and bias**, the number of other studies on the same question, and, importantly, the ratio of true to no relationships among the relationships probed in each scientific field. In this framework, **a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance**. Simulations show that for most study designs and settings, it is more likely for a research claim to be false than true. Moreover, for many current scientific fields, claimed research findings may often be simply accurate measures of the prevailing bias. In this essay, I discuss the implications of these problems for the conduct and interpretation of research.

http://www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.0020124

Bias

Unintentional bias

- Overconfidence
- Representativeness
- Anchoring
- Bounded rationality
- Availability / lamp posting
- Implicit assumptions

Motivational bias (CoI)

- Strategic research behaviour
- Interests with regard to outcome of analysis

http://www.nusap.net/modules.php?op=modload&name=NS-Glossary&file=index&letter=B

Issues in data quality

- Relevance / pertinence
- Sample size
- Representativeness
- Scale issues (temporal / spatial / system)
- Accuracy
- Reproducibility
- Consistency
- Traceability / documentation
- Completeness
- Maintainability
- Standardization
- Portability

Knowledge systems for sustainable development

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The challenge of meeting human development needs while protecting the earth's life support systems confronts scientists, technologists, policy makers, and communities from local to global levels. Many believe that science and technology (S&T) must play a more central role in sustainable development, yet little systematic scholarship exists on how to create institutions that effectively harness S&T for sustainability. This study suggests that efforts to mobilize S&T for sustainability are more likely to be effective when they manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce. Effective systems apply a variety of institutional mechanisms that facilitate communication, translation and mediation across boundaries.

duct, and fair in its treatment of opposing views and interests. Our work shows these attributes are tightly coupled, such that efforts to enhance any one normally incur a cost to the others (7–9).

Finally, a wide range of studies have identified the importance to effective science advising of "boundary work" carried out at the interface between communities of experts and communities of decision makers. This work highlights the prevalence of different norms and expectations in the two communities regarding such crucial concepts as what constitutes reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty. It points out the difficulty in effective communication between the communities that results

Quality of knowledge for sustainability:

- **Salience**: relevance of the assessment to the needs of decision makers
- **Credibility**: scientific adequacy of the technical evidence and arguments
- **Legitimacy**: production of information & technology has been respectful of stakeholders' divergent values & beliefs, unbiased in its conduct, & fair in its treatment of opposing views & interests.

http://www.pnas.orgcgidoi10.1073pnas.1231332100/