November 7, 2017

12th Berlin Debate on Science and Science Policy
12. Berliner Wissenschaftsgespräch

Is Knowledge Losing Power? Towards a More Resilient Science System for the 21st Century

Summary Report

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Foreword

In 2001, the Robert Bosch Stiftung initiated the *Berlin Debate on Science and Science Policy*, with the aim to offer a forum for open and critical debate with a small number of high-ranking scientists and international decision-makers in science. The focus of this format is on exchanging ideas and best practices, on identifying deficits and converting them into positive policy concepts and practical recommendations.

Choosing the right topic for each year´s debate is a difficult, yet rewarding task. What are the mega trends in science and science policy that need to be addressed early on? What are the challenges scientists all over the world are facing? The choice for the 12th Berlin Debate was – sadly enough – rather straightforward. We simply could not ignore the fact that science is under attack. We simply could not ignore that the word *fact* itself has become a *contested concept*. And we had to acknowledge that scientists all over the world felt compelled to take the streets. Not for higher wages or better working conditions. Far from it! One of the protest signs of the Berlin March for Science summed up their true concern beautifully: *"I can´t believe I´m protesting for reality".*

But it might not be as simple as that. We all know that science can´t claim to own the truth. We all know that megatrends like globalization and digitalization and the transition from "small" to "big science" have fundamentally changed the way scientists are working. And we all know the flaws and excesses of this development, from a struggling peer review system to scientific misconduct.

In the light of these developments, it´s no small wonder that citizens increasingly question the authority of scientists. In a recent representative population survey on science and research in Germany, called "Science Barometer", 12% of the respondents claimed they did not trust science. And a frightening percentage of 37% said they were not sure. The respondents consider the dependency on funders of research as a main reason for distrust in scientists. The influence of business on science is regarded as too strong by almost two thirds. Another rather alarming finding: Less than 50% of the respondents agreed with the statement that scientists work for the benefit of society. But they do not only criticize: 40% say they would like to participate personally in a scientific research project. These findings give us some hints on how we might succeed in addressing science scepticism. Many more ideas emerged through the discussions at the 12th Berlin Debate on Science and Science Policy.

The Robert Bosch Stiftung, established in 1964 and one of the leading private foundations in Europe, is clearly committed to fighting for a rightful place for science in this society. Our purpose as a foundation is to promote public

welfare, to strengthen our democracy and the ties that hold this society together. In this context, we consider science to be of pivotal importance. Science is based on an open and free exchange of arguments. It is committed to evidence and always willing to discard any theory that proved itself wrong. Our democracy and society can greatly benefit from this operating mode and its results. But only if science succeeds in staying in touch with society. Therefore, science is called to reach far beyond the pure communication of results. It needs to engage the public in an ongoing process of mutual exchange and learning.

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Executive Summary and Recommendations

The 12th Berlin Debate on Science and Science Policy convened at the Berlin Office of the Robert Bosch Foundation on 7th November 2017 to consider the question, 'Is Knowledge Losing Power?' and to propose ways to secure a more resilient science system as we move forwards in the 21st century.

Is knowledge losing power?

The knowledge that we have today is the product of centuries of scientific endeavor. We pride ourselves in the first quarter of the 21st century as being a 'Knowledge Society', understanding more about the world than our predecessors. Science is the instrument through which society has gained knowledge and understanding about the social and natural world. It is the backbone of industry and modern medicine and technology. It is the rock-solid foundation on which we make evidence-based decisions and plan for the future – or so it seems.

Yet as the Berlin Debate heard, many in the scientific community are experiencing waves of discomfort over whether the role of knowledge in society is becoming weaker. Certainly, in areas such as climate science and public health vaccination programs, proponents of evidence-based decision-making have found themselves up against powerful lobbies who are seeking to influence the public to turn a blind eye to evidence. While in other areas of life and sections of society, there is a benign indifference to the contribution of science to society.

At the same time, with an explosion in the numbers of scientists, research institutions and programs of investigation over the past few decades, comes a magnification of the problems in science, such as quality control issues, questionable criteria for deciding who gets the best jobs and funding, and the potential for false claims and fraud. These become easy fodder for the anti-science lobby wishing to undermine the credibility of scientists.

An age-old conflict

Moderating voices reminded the Berlin Debate that science has rarely had an easy ride, and fighting for credibility comes with the territory. Throughout history, science has experienced conflict with other pillars of society. In previous centuries, pioneers of new ideas and ways of thinking were sometimes at odds with religion or the monarchy. Today, they find themselves struggling against social attitudes and the darker forces of politics.

There were also voices to be heard during the debate who believed that all is not doom and gloom. That in fact different data point to different conclusions about public attitudes to science. The recent 'Science Barometer' survey of

public attitudes to science in Germany suggests that a significant section of society do not trust science, or are unsure about their level of confidence in science. Whereas other surveys in the USA, UK and Australia have indicated strong public faith in science.

To boost resilience of science

So what steps can be taken now to ensure that the science system maintains resilience into the 21st century, such that knowledge gains rather than loses power?

The Berlin Debate heard lively discussions and produced a raft of recommendations for scientists, policy makers, funders and publishers, to help to strengthen the quality and integrity of science and its relevance to society:

Revision of the evaluation system

1. Move beyond the narrow obsession with counting research publications and journal impact factors when it comes to evaluating researchers.

2. Create new evaluation systems that broaden the definition of research quality and widen the range of criteria against which it is judged (public engagement, teaching, peer review, committee work, etc.).

3. Put pressure on deans and other key players and/or create positive incentives for them to use these new evaluation systems.

4. Reduce the volume of papers being published. Restrict the number of papers a new job applicant has to cite.

5. Appreciate the support researchers give to others and award the synthesis of evidence.

6. Tackle the risks of poor quality publication, low reproducibility of data and false claims through new approaches and technologies, like post-publication peer review.

7. Get rid of the word ‘excellence’.

Science in service of society

8. Give greater weight to the relevance of research to society – at the levels of both individual scientists and institutions.

9. Encourage researchers to become more engaged in science policy around societal issues.

10. Integrate these aspects into the evaluation systems, so that they are measured and incentivized.

Dialogue with the public

11. Encourage scientists and their institutions to engage in meaningful and productive dialogue with the public – to deepen understanding on both sides – and empower the public to have a role in shaping the future of science.

12. Encourage scientific organizations including universities to invest more resources in public engagement with science.

13. Fund research on how to evaluate the quality of public engagement.

14. Reward (and maybe even pay) scientists for public engagement work.

15. Identify and honor scientists who can be seen as role models with respect to their public engagement. Fight the ‘culture of busyness’ that prevents scientists from investing time in outreach activities.

16. Strengthen the (strategic) cooperation between the different players involved in public engagement (science journalists, funding agencies, science organizations, publishers etc.)

17. Create places of co-living and co-production of knowledge that bring together scientists and non-scientists, to enable mutual learning and a broader concept of knowledge.

Public image of science

18. Communicate a more authentic and humble picture of science to the public; one that conveys the realities of the scientific process and transparency about donors and interests.

19. Make sure the public understands the difference between science and technology.

20. Give reassurance to society and especially policy makers that uncertainty is the gateway to new knowledge and ideas and that decisions can be based on evidence, not political rhetoric.

21. Create possibilities and incentives for scientists to publish ‘unspectacular results’ of research.

22. Nurture future science leaders to think broadly and enable culture change in science.

Introduction
Science in Transition: Why and How Has Science Gone Wrong?

The rise of 'big science'

There has been a staggeringly rapid expansion of science over the past three decades. This is reflected in both numbers of scientists in different countries, and the huge investments in science from both private and government funders. The US National Institutes of Health, for example, now spends $32.3 billion USD annually on biomedical research, according to **Frank Miedema**, Professor of Immunology, Dean and Vice-President of the Executive Board of UMC Utrecht.

Chasing after research funding also involves bigger numbers: the ever-larger international multidisciplinary teams and consortia, bringing together university and industry partners, and the increasingly expensive equipment needed. "You have to spend millions per year just keeping the lab going," Miedema revealed in his opening statement to the debate.

Accompanying these growth spurts is a bursting forth of new technologies, methods, and 'break-through' concepts. And with a 3% annual growth rate in the number of scientific publications, there are now 1.5 million scientific papers being published per year. This is driven, said Miedema, by a 'publish or perish' mantra shared by researchers and university deans alike. "In many cases the committees are counting and looking at impact factors and not reading and not really understanding."

Miedema expressed concern that this growth in science, and the narrow focus on publications by appointment committees, is having a detrimental effect on quality.

"Quality is suffering. People will not ask how many papers did you peer review, how much time did you spend on your colleagues' papers? (…) People get overwhelmed by the peer review journals, so they give the reviewing to their PhD to do. And we all notice."

In a position paper published in 2013 titled, 'Why science does not work as it should, and what to do about it´, Miedema and a group of colleagues initiated what has become a global campaign to address a perceived narrowing of how quality in science is judged, and undervaluing of societal relevance (see www.scienceintransition.nl).

Besides the obsession with impact factors, Science in Transition highlights the lack of appreciation for the support that scientists give to others, whether through peer review or serving on committees. Miedema commented about

the frequent failure to report openly the results of clinical studies, and lack of reproducibility between studies, including in cancer research. Some subject areas are well served, while societal issues, and medical areas such as geriatrics, receive little attention.

Miedema expressed a wish to see more research organized as multidisciplinary programs targeted to grand challenges, clinical and health needs, and the involvement of societal stakeholders, such as patient organizations. He advocated the development and use of new indicators for impact besides metrics around publications.

Session 1:
Enhancing Research Quality and Integrity: New Strategies and Approaches

One of the most obvious reasons for the current crisis of confidence in science is the way in which researchers are assessed. The 12th Berlin Debate on Science and Science Policy tackled the issue head-on with a look at three new approaches that aim to reinforce the quality and integrity of research.

Taking a stand against bad evaluation

In 2015, concerned about the fact that research evaluation is now led by data rather than by judgment, a group of scientists published in the journal *Nature* a set of 10 guiding principles known as the *Leiden Manifesto*.

The purpose of the Manifesto was to "take a stand against the fast proliferating bad practice in the use of metrics applied to research evaluation," said lead author **Diana Hicks**, Professor of Public Policy at the Georgia Institute of Technology, addressing the Berlin Debate in her short input statement.

Quantitative assessment should be only one part of evaluation, according to the Manifesto. Other aspects to consider are the research missions of the institute, group or researcher, such as whether in basic, applied research, or policy development, and excellence in national language literature. Also important are the researcher's broader portfolio of expertise, experience, activities, and influence.

The Manifesto has been translated into 17 languages and guided research policy discussions in Brazil, Panama and Portugal. The universities of Ghent, Loughborough, Bath and Indiana have revised their evaluation practices according to its principles, and in 2016, the European Association for the Study of Science and Technology (EASST) awarded the Leiden Manifesto their Ziman award for collaborative promotion of public interaction with science and technology.

"Our intent was to provide scientists with a reference for good practice to use in taking a stand against bad evaluation practice. [….] That we have had a little bit of demonstrable success is quite gratifying," noted Hicks.

She also reminded participants of the benefits of the recent growth in science, such as (in the USA) a much wider geographical spread of universities involved in research, beyond Ivy League institutions. And "a lot more areas of the country can benefit from the economic spin-offs of research," she noted. "Science has become so very big, which means more diverse, more people

are participating who are not in the inside club." These include women and people from ethnic minority communities, bringing a broader research agenda.

Rethinking research quality and its evaluation

In 2014, following a similar "sense of concern and urgency" about research evaluation, Canadian funding agency IDRC developed an alternative called the Research Quality Plus Assessment Framework (RQ+). As described by **Zenda Ofir**, Independent International Evaluator and one of its designers, RQ+ views research from a complex systems perspective and places emphasis on its meaning in society. It addresses some of the same concerns as the Leiden Manifesto.

RQ+ broadens the definition of research quality and the criteria against which it is judged. It considers the context in which the research takes place and the main influences on the quality of the research. "Science-centric thinking – where research assessment is solely a scientific matter that takes place in isolation from the context of its use – is no longer desirable or useful," said Ofir in her input statement. She added, "Science can no longer be considered a largely academic enterprise divorced from societal concerns about global and development goals."

In the RQ+ framework, prominence is given to a multi-dimensional view of research quality that includes research integrity (methodological rigor), legitimacy (reflecting the values of the organization or society), importance (originality and relevance) and positioning for use (rather than its actual use and impact). Among others it recognizes the value of use-inspired and applied research, and the value of crossing disciplinary, sector and geographic boundaries. It also has enough flexibility to tailor the assessment criteria to the values of an organization or group.

An independent meta-analysis of the quality of 175 IDRC-supported "research for development" projects between 2010 and 2015 found that Southern researchers are scoring highest for scientific integrity and originality. In particular, there was a strong correlation between measures of scientific integrity and how well the research was made available for use. "So researchers conducting rigorous research also do their best to ensure that their work gets to the right people, on time, in ways that they can use it," noted Ofir.

Trip advisor for researchers

Linked to the question of quality in research is the peer review system, by which scientists appraise the papers submitted by others for publication in academic journals. Traditionally, journals select peer reviewers working in the

same field to contribute a critique, often anonymously. But it is a system that is open to abuse, as peer reviewers may have undeclared conflicts of interest, or may fail to examine papers adequately, according to **Boris Barbour**, Research Director at CNRS, France.

He told the Berlin Debate in his input statement that many papers get through peer review despite containing poor quality data or false claims. A famous example is the claim, published by Andrew Wakefield et al in *The Lancet* in 1998, that autism is linked to the measles, mumps and rubella vaccine. This was eventually retracted as entirely false, in 2010, by which time measles outbreaks had occurred as worried parents refused to allow their children to be vaccinated.

To combat poor practice, an alternative open peer review system was launched in 2012, called *PubPeer*. This invites scientific peers to appraise research publications on a public, free to access online platform. Run by a non-profit foundation, independent of academic journals and author reputation, PubPeer is a kind of 'Trip Advisor for researchers', because it allows any number of people to contribute views on any published study through anonymous comment boxes, said Barbour, who is Co-Organizer of PubPeer. Key safeguards include the stipulation that the comments must be based on publicly verifiable information, that authors have a right of reply, and that the PubPeer team moderates unregistered comments. Questions and problems surrounding papers can be shared rapidly and directly between researchers, which can help bypass conflicts of interest.

"In the best of cases, you can benefit from multiple world experts commenting on a paper, who have had time to think about it, to reflect on it," said Barbour.

A system resistant to change

Although they welcomed the new initiatives – the Leiden Manifesto, RQ+ and PubPeer – the participants of the Berlin Debate questioned whether such efforts would be sufficient to propel science forwards in the 21st century, robust and fit for purpose. The necessary changes are not happening quickly or widely enough.

"What does it take for the emperor, who has no clothes, to see?" asked **Helga Nowotny**, former President of the European Research Council (ERC) and Chair of the ERA Council Forum Austria.

"Everyone around this table knows where the problems are, but nothing is changing. We have to look at who's gaining and who's losing from the current system. Maybe most of the people in science are gaining and that is the

reason why nothing has changed yet," said **Martina Brockmeier**, Chair of the German Council of Sciences and Humanities.

So who is responsible? The key players it seems are the funding agencies, publishers, and the universities where many scientists base their careers, with appointments based on publication metrics.

Big funding, big influence

With regard to research funding, it was inevitable that 'big science' became an important element of biomedical research, according to **Mark Walport**, Chief Executive Designate of UK Research and Innovation. "If you look at the genetic association studies of 30 or 40 years ago, many of them, for example, were underpowered and statistically not robust." This prompted a shift in funding strategy at the Wellcome Trust towards supporting large consortia to do genetic association studies, with the result "that genetics became much more reliable, and the papers did have 50 to 100 authors", he commented.

A problem with current research funding is the 'chicken and egg' situation that money follows success rather than being a spur for the most important research, according to **Philip Campbell**, Editor-in-Chief of *Nature*. "To what extent, with the hugely concentrated funding systems and excellence initiatives we have, are we creating the winners rather than [having] funding follow quality?" he asked.

Pressure to publish

In the case of publishing, it might be unrealistic to expect publishers to be the only ones taking responsibility for improving quality – they are inundated with scientific papers which challenges their capacity to perform all the quality control checks required. *Nature* journals are "deluged with bad gels and bad blots," said Campbell. Such transgressions are a sign of "something coming out of the system of research groups that are not appropriately led." This reflects the pressure that principle investigators are under, with "too little time or too much success to validate their group's output", he added.

There is a danger too that over-promotion of single papers sends conflicting messages to the public and policy makers, and rarely provides the bigger picture. "We spend all our time rewarding people for publishing their paper and then their next paper, but we don't really reward people for doing the work to put the evidence-synthesis together," according to Walport. This in itself can undermine public trust in science.

Nowotny drew attention to a new idea for improving quality and reducing quantity of papers in genomic regulation. Rather than individual groups

competing to publish their papers in top journals on individual genes, or sets of genes, larger groups could work together and publish findings on larger sets
of genes. “We have to break the traditional ways of doing science or publishing that come from another era,” said Nowotny.

Mathematics and psychology: the exceptions?

Some participants were keen to stress that the problems of ‘big science’ are not found uniformly across the disciplines. Using metrics to assess research output is widespread in life sciences, but not in mathematics, according to **Jean-Pierre Bourguignon,** President of the European Research Council (ERC). “As a mathematician I feel on the outside. We need to put more work into understanding why we are in this situation.” Bourguignon suggested that the short lifespan of many life sciences papers may be to blame, such that metrics become a way to demonstrate impact and the intellectual environment at the time of publication, before results become superseded by others. “And then you just count because it’s very difficult to do anything else,” he said.

Another difference between life sciences and mathematics is fragmentation of the life sciences community into small groups, working across a multitude of questions, according to Bourguignon. “There are few people with a global view of things….It creates a special situation, which makes it difficult to monitor progress.”

In psychology, problems such as the difficulty in replicating the findings of others, once so prevalent, are in the process of being addressed and are ultimately likely to be resolved, according to **Stephan Lewandowsky**, who holds a Chair in Cognitive Psychology at the University of Bristol. “The last five years have been revolutionary in the transformation of what’s considered acceptable and what isn’t. Data availability, preregistration, increased reliance on modeling… I have a list of maybe a dozen things that have become quite commonplace in my community,” he explained.

Responsibility lies with universities

With its emphasis on publications and fundraising, research evaluation is missing other important contributions that many scientists are making. As Brockmeier stressed, it is a self-perpetuating situation. “Most of the reputation comes from publication, from raising soft money, not from teaching, not from knowledge transfer, not from infrastructure... Lots of people are gaining from that.”

Changing the situation will require engagement with university leadership, specifically the deans, according to Campbell. “The funding agencies, the

researchers, the journals, we're all in the system, but ultimately it's the academics who have to be able to have agency."

Campbell praised Miedema for his initiative as a university dean, for establishing broader assessment criteria, and for scientists to be penalized if they underperform in leadership. "Only you, Frank, can make a difference as dean!"

New incentives

External pressure is needed to make institutions change their practice, agreed Miedema. He gave the example of the mandatory requirement for 'open science', with data storage and 'fair data' imposed by the ERC under the next Framework 9 funding round. This has encouraged countries such as Croatia to embrace open access and data sharing. "This is exactly the way it should be done because you guys have the money… Then I have to move as a dean because this gives me an enormous handle to act." He pointed to areas of science including cancer research that could benefit from a more fundamental change in the scientific system. With some types of cancer, life expectancy remains the same as it was 50 years ago.

Tracey Brown, Director of Sense About Science, called for new incentives for greater openness of research. She referred to the AllTrials campaign to promote transparency in clinical trials data, and the under-reporting of trial results in the USA. "Change will only happen if you incentivize. We have to start publishing league tables of deans whose clinical trials are not published."

Beyond the tweaks

Ofir criticized current efforts as inadequate for the scale of change required for science to move forwards in future. "I'm worried that we are tweaking things from within and perhaps not thinking deeply enough…We need to think beyond the tweaks…We need to think far more deeply about what science would have looked like today if we had invented it for today."

Such deeper questioning will require a new generation of leaders who think differently, proposed **Johannes Vogel**, Director General of the Museum für Naturkunde, Berlin. He related his own experience of training as a scientist outside of the university system, at the National History Museum in London. Here, he felt that he was allowed to progress by making and learning from mistakes. He voiced concern about whether the current university environment could support the necessary personal growth for new leadership. "Change needs to be led from the front and we need to have people who can embody this new way of thinking and dealing with science that we all aspire to. We need to spend a lot more time developing these skills outside of science."

Stefan Selke, Research Professor for Transformative and Public Science at Furtwangen University, echoed Vogel's concerns about future scientists who, he suggested, "will suffer a huge crisis of gratification." They can "choose to fly like batman in the main channels, accelerating the vicious circle, copying the strategies they already know," or look for alternative role models. "But there are no alternative role models or systems of gratification inside the science systems. It's more a question about science culture or culture of the society itself."

Reflexions: The Cunning of Uncertainty

The idea that knowledge is losing power, that the significance of science to society is diminishing, is not new. Historically, science has always had to contend with the powers of the day, such as the church or the monarchy and later with totalitarian regimes. And yet science has demonstrated a remarkable capacity for resilience, explained Helga Nowotny in a short keynote between sessions I and II.

Nowotny was relatively optimistic that science can remain resilient in the face of today's challenges, based on three assumptions.

Firstly, Science Works! This has been demonstrated through its impressive achievements and is based on a sophisticated system of 'organized scepticism'. The so-called 'scientific method' entails cross-validation and the certification of results through publication. Even if the peer-review system is flawed, it is still the best we have and -most of the time it enables science to be self-correcting.

Secondly, the scientific community continues to harbor a profound belief in what Abraham Flexner described in 1939 as "the usefulness of useless knowledge". Research without an obvious endpoint or targeted application may prove to be extremely valuable to society. "We have four hundred years of modern science to show how seemingly useless knowledge turned out to be very useful in unexpected ways. Serendipity – finding something one was not looking for and recognizing its significance – is a helpful ally for science to advance."

Thirdly, science is resilient because scientists accept and even embrace the uncertainty which is inherent in the process of research, said Nowotny. "Basic research thrives on the cusp of uncertainty. There are exciting moments when one is moving into the territory of the yet unknown or seeing something no one has seen before. This is in sharp contrast with how society and politicians deal with uncertainty. Society craves for certainty."

In her book 'The Cunning of Uncertainty", published in 2015, Nowotny explored the inherent link between science and uncertainty. The word 'cunning' is a metaphor for the very positive relationship that scientists have with uncertainty, accepting that their work can have unintended consequences, and allowing serendipity to play a part.

Session 2:
Securing Legitimacy and Relevance: New Ways of Working with 'the Public'

The Berlin Debate looked for possible solutions to the crisis of confidence in science through working with 'the public' to secure legitimacy and relevance.

But public engagement is not straightforward when trust is fragile. Like any relationship, the building of trust between scientists and society takes time and resources. And it requires understanding of the forces that can either strengthen or destroy trust.

Political interference

Speakers at the Berlin Debate disagreed over how much scientists are currently held in high esteem by the public. Although the German Science Barometer survey raised concerns about trust in science, data from the USA, Australia and the UK suggest that "scientists are right up there in being the most trusted segment of society," and "the majority of people think that scientists are telling the truth," said Lewandowsky.

What can disrupt public confidence is politically motivated attempts to undermine the credibility of scientists. This happens when scientists point to data that others would prefer to keep hidden. In his short input statement to Session II, Lewandowsky gave the example of scientists providing evidence from the 1970s onwards about the dangers of environmental pollution, smoking, and exposure to asbestos, and the need for tighter regulatory controls on public health grounds. This was "knowledge that was incompatible with further industrialization, enterprise and the progress that republicans like to see," he said.

It is perhaps no surprise then, that surveys in the USA have revealed differences in public trust according to the political opinions of the respondents. "Trust in science among republicans has been declining since the mid-70s," Lewandowsky commented. He added that the same right-wing anti-science agenda is also behind a "fairly vociferous and mendacious campaign against climate change and climate science."

He also recounted the example of how in 2015, the chair of the US Congress Science and Technology Committee accused NOAA of manipulating and hiding climate data. The chair made a demand for openness and embarked on legal proceedings to subpoena the data – which anyone "could download with a few clicks from NOAA". It was merely a political ploy and "convenient to pretend that it had to be got at in this way."

To tackle the problem, Lewandowsky proposed that scientists should position themselves as people who “can speak truth to power,” and challenge political statements. Scientists should also inform the public about the political motivations of their critics. In his own recent study, members of the public were told about past efforts by the tobacco industry to undermine medical science. The understanding of political maneuvering was transferable, with the result that the audience became less susceptible to misinformation about climate science.

“So it’s awareness, critical analysis of the context and pointing out why it is that people are opposing us that helps us to get out of this,” he suggested.

Fear of the public

Nurturing better understanding among the public is only one side of the equation, according to Brown. In her input statement, she pointed out that scientists are sometimes in danger of “conjuring up some horrific image of the public that’s born of our own fears.” Scientists sometimes seem to experience unnecessary anxiety about the public, as an imaginary opponent. The reality, however, is very different. The public, she says, really want to know about scientific evidence.

To illustrate this, Brown showed a video about the #EvidenceMatters campaign in which 100 young citizens visited the European Parliament in June 2017 to discuss with MEPs why scientific evidence matters to them in their lives (see https://www.youtube.com/watch?v=BQtKmTZ4fOo).

If scientists were more collaborative, they would overcome fear of this public ‘monster’. “Rather than seeking to counter people, seek out instead what it is that groups and communities want to understand about their world… and think about how to work with them,” said Brown. It’s easy to label people as “hard to reach” when in fact, people may have many moments in their life when they are wrestling with a decision, such as over drug treatment, and want a better understanding. “Are our tools that re-engage ready and available to people in those situations?” she asked.

The friendly face of science

Seeing the public as an ally, not a foe, is definitely the way forward, agreed Vogel in his input statement. To enable this means providing the right environment for public engagement. One example is the Berlin Museum für Naturkunde, which Vogel described as the “friendly face of science in this region” and which is the most visited of all the 170 museums in Berlin.

Given the numbers of scientific institutions in the western world, the potential for public engagement is “fantastic”, but it requires a change of policy and more resources in order to fulfill a vision of “broader, deeper, bottom-up public engagement in science,” said Vogel.

Institutions, he said, “would need to take it on board as their remit, and put the money into it, and that in my opinion would be the hardest thing – next to culture change and leadership.”

Trust undermined: ‘the establishment’

To help define the questions around public trust, Mark Walport stressed the importance of distinguishing between public attitudes towards scientists, their discoveries, and their conduct, and what influences these.

For scientists, being seen as ‘part of the establishment’ is an unwelcome burden. “In a time when people are suspicious of the establishment, we are part of the establishment. Science is seen as being pro-globalism… universities are global institutions.” And yet, “when it comes to the Higgs boson, gravitational waves, the discoveries of cancer genetics, people are completely accepting, they admire science. Even when people claim that neutrinos are faster than light, which was wrong, it wasn’t the public that got upset, it was the professional community,” said Walport.

What made matters worse, was when scientists stepped beyond the boundaries to tell people how they should live. “It’s when scientists become advocates rather than scientists. So for example with GMOs – the argument isn’t about the science it’s about personal values and recognizing some people believe we shouldn’t fiddle with nature,” said Walport. The answer, he said, was better public engagement in which scientists do not confuse the discussion around science with the discussion about values.

Alicia Wise, Senior Vice President for Global Strategic Networks at Elsevier, agreed that wider public engagement was needed. “We need to think deeply about how we engage with public policy development, the education system, children and adults, and how they become interested. We need to take lessons from the museum sector. How do you really engage people hands on in a really imaginative way in science? How do you push and pull at the same time?”

“What has science ever done for me?”

This question was posed by **Jack Stilgoe**, Senior Lecturer in the Department of Science and Technology Studies at University College London, drawing from the opening remarks of Richard Jones, Professor of Physics at the

University of Sheffield, at a roundtable discussion at Cambridge's Centre for Science and Policy about Rotherham, a relatively poor de-industrialized town in the UK.. Jones described a growing inequality among UK citizens over whether they benefited, or believe that they benefited, from scientific research.

The Rotherham example signaled the need for scientists to engage with the public to promote better understanding and ownership of research results. "Science is unavoidably an elite activity but it doesn't have to be an elitist activity," Stilgoe said.

The meaning of trust

Debate participants had different interpretations of the concept of trust in science. Some talked about the public having confidence in the purpose of research. Others emphasized that trust in science was more to do with who and where research took place, whether in universities or private industry. When industry gets involved, this is often where "trust starts to diminish very rapidly," suggested moderator **Vivienne Parry**.

Such mistrust of industry can be explained by people's attitude towards research institutions, according to Stilgoe. "When we ask about trust in science, the question is normally phrased 'do you trust scientists to tell the truth?' But that only captures part of people's relationships with institutions of science. The other part is, 'is this activity or institution sharing my interests and values?' Then it becomes a question of who benefits, and it becomes a political question." Such questions, in turn, drive the demand for transparency around clinical trials.

Some pointed out that industry is not a single entity, and that there is overlap in where public and private-funded research occurs. Pitching these two against each other does not help instill public confidence. "There are enormous shared challenges that we could work together to overcome in the public's trust and understanding and support for research wherever it's done," said Wise. She advocated a more collaborative approach to increasing public understanding about research across the private/public sectors.

Issues around trust can, in extreme cases, put whole careers in jeopardy, according to **Carlo Rizzuto,** Executive Director of ELI-DC AISBL. After the Aquila earthquake in 2013, scientists were accused of causing deaths because they had failed to anticipate the earthquake and issue warnings. This backlash occurred because the public and politicians often have unrealistic expectations which some scientists inadvertently encourage by exaggerating the significance of their findings. "They hunt for money to do their research. Many over-emphasize the importance of their research," he said.

Vogel seconded this, highlighting the contrast between the qualities of “fierce resolve and humility” shown by leaders, and the traits encouraged in science. “How can you show humility when you are constantly asked to show that you are the best?” he asked.

Public engagement: the price to pay

The Berlin Debate examined some of the ways in which scientists can get involved in public engagement, the rewards and consequences.

Museums can play a key role in both demonstrating scientific excellence and public engagement, according to Vogel, with the added benefit that museum scientists also gain a wider outlook, new skills and learning opportunities.

Universities can gain public confidence through their teaching and transfer of knowledge to small enterprises. Public trust does not have to depend solely on the quality of an institution’s research, noted **Philipp Antony**, Head of the Department for Science and Education at the Heinrich Böll Foundation. In agreement, Hicks spoke of the “amazingly rich way” that US universities have of engaging with local communities. Many students do internships, for example, to help run local legislature and museums, redevelop neighborhoods and run sports programs.

While public engagement by a scientific institution can be a strength, individual scientists may pay a price. “You stand alone in a cold wind, and the highest price you pay as a scientist is to be regarded as a non-scientist, no longer belonging to the tribe,” warned Selke.

There remains a lack of incentives for scientists to do public engagement, noted **Markus Weisskopf**, Executive Director at Wissenschaft im Dialog. “It can still be an obstacle for a scientific career to do too much engagement, TV. The funding organizations should maybe change that.”

Brockmeier expressed concern about the time constraints on researchers. “We only have 24 hours. It’s a trade-off. If you spend some hours per day on talking to the public you are losing that time to do research and to publish papers. Accordingly, we need to value public engagement higher to give incentives to researchers to spend part of their valuable time on public engagement.”

Recognition for public engagement

A different appraisal system is needed if scientists are to be recognized for public engagement work. “If it is valuable, then let’s have it evaluated and then it would be consistent with the rest of what the researchers do,” said

Bourguignon. He gave the example of having worked with artists commissioned by the Fondation Cartier, to create a public exhibition about mathematics. Initially

his colleagues thought the idea inappropriate because they feared being devalued as mathematicians. But to everyone's astonishment, 80,000 people visited the exhibition and the brochure was most highly sold at Fondation Cartier.

How best to evaluate public engagement work remains a challenge, agreed several participants of the Berlin Debate. According to Brockmeier, it might be easier to do such evaluation at the level of institutions rather than individuals.

Brown stressed the need for building relationships. "Relationships build your ability to understand what you're doing, to think of synergies with other things that are going on, and opportunities." Through dialogue, she said, scientists develop different ways to express their ideas. A recent example was a meeting between statisticians and families whose babies had received heart surgery. "Immediately the researchers started speaking differently – human. You can all speak in human – that will benefit everybody. We all become better human beings."

Concluding Discussion

The complexity of the issues raised during the Berlin Debate were all too apparent. Zenda Ofir commented that “every topic we talk about has a very complex set of issues behind it. Solutions are very difficult to find.”

Nonetheless the participants moved on to conclude the debate by formulating their most pressing and promising wishes for a reform of the science system.

Tackling wider societal issues

Hicks urged researchers to become more engaged in science policy around societal issues. It would be important, she said, that scientists see this as intellectually challenging so that they engage with societal issues “in an aspirational way that helps to negate this second-class citizenship issue that always dogs public engagement.”

Wise proposed that China could lead the way for science. With its recently embellished science policy – thanks to a new leadership under President Xi – Chinese science is aiming to go beyond the previous goal of economic advancement. After recent conversations with Chinese science leaders, Wise was impressed by a new philosophy that “science should first and foremost be in the service of society”, focusing on problems such as providing care for aging populations.

Wise also wished for better ways to evaluate the quality of public engagement. This could cover the effectiveness of knowledge transfer to the public, the numbers of people engaged, evidence of co-production, what resources are allocated by a university, and the number of public policies influenced by evidence.

Lewandowsky suggested reducing the inequality in income that has arisen from the rewarding of scientists who perform well according to metrics. This is worsening due to the extra demands on scientists’ time to make data accessible and to do public engagement work, all without extra pay. Lewandowsky sees this among his own colleagues in psychology. “They have said to us openness and transparency is horrible because it makes us do more things that no one is getting paid for.” His solution would be to redistribute funds and to give universities more money to fund the average researcher instead of only rewarding the top 1%.

Antony’s suggestions for the future were to examine the function of universities as research institutions, reduce the number of papers being published, “because nobody has time to read the papers,” and restrict the number of scientific papers that a new job applicant has to cite.

Weisskopf wished for more strategic cooperation between the different actors who could be involved in public engagement and coproduction, especially scientific organizations, funding bodies, and science journalists. “I do not think they work together very much at the moment. We all need more courage when it comes to public engagement and co-production.”

Brown emphasized that the research community should become more flexible and responsive to new ideas and challenges, particularly when even well-established institutions come under attack. She urged scientists to get rid of “this culture of busyness where people put forward things they do as reasons not to do important things.”

Brown also called for greater transparency about the use of research on social media, citing the example of during the last UK general election, when it was not possible to find out what adverts were being displayed to people on Facebook. “Social media is making a mockery out of all the huge gains made in political and social research – what shapes their views, etc., because they do not share that information.”

Reforming the use of metrics

Several speakers wished for a change in the way that metrics are used, and the significance attached to them. Barbour wanted scientists to use fewer metrics and have more fun debating results in public. “We should thrash out our ideas, confront them, and discuss with the public. It would be more fun to worry about what’s in the paper than what journal it’s published in… It would draw in capable people from the public.”

Campbell also shared a fantasy in relation to metrics, in which “every university and every funding agency produces half the number of papers per dollar or euro spent” compared to today. This would enable researchers to “do better management, looking after postdocs, communicating better.”

Expressing her concerns about the quality of science, Zenda Ofir suggested that “we should do everything possible to expand our notion of quality and ensure that that gets the right incentives to actually influence the system and to remove some of the challenges that the Leiden manifesto brought to the fore.” She pointed to China as a new opportunity to eliminate some of the obstacles and develop a better science system, given the vast amounts of money and scientific output. “There is huge power in being able to mobilize a billion people and whatever number of scientists to do things in a particular way… I wish there was a way to harness that.”

Taking a broader view, Stilgoe offered a seemingly very simple solution: “I would get rid of one word: ‘excellence’.” This could solve a raft of problems, including the obsession with metrics, concentration of scientific resources in too few places and the pressures this brings on public engagement work and strategic mission-oriented science.

A very different notion came from Selke, who recounted his experience of a slower pace of life at a monastery where he once did ethnographic research. “One day I asked the question, ‘how long does it take to reorganize a library?’ The monk replied ‘not so long, probably 70 to 80 years.’” Selke therefore proposed creating a place of co-living and co-production of knowledge that brings together scientists and non-scientists for at least two years, to enable mutual learning and a broader concept of knowledge.

More realistic portrayal of science

Nowotny recommended the communication of a more “authentic and humble” picture of science in future – one that conveys more the realities of the scientific process: the set-backs, gaps in knowledge and uncertainty. Being more open about these things would help to combat the “big pressures on scientists to come up with false certainties” – which politicians, the public and even other scientists seem to expect.

An example would be in the field of gene therapy (CRISPR), which has prompted questions about the idea of ‘designer babies’. Scientists often reject the idea as future fantasy that may never happen. But they can also explain that they are working on improving the technology involved, said Nowotny.

Similarly, Brockmeier called for a “more realistic view of science to the public, including the fact that most research is independent and not influenced by its donors.” This could help counteract the view highlighted in the ‘Science Barometer’ that research funders might be unduly influencing the direction of research. It would also help if more of the “unspectacular results” of research were published, to enable other scientists to avoid repeating the same work.

Rizzuto urged for greater clarity over what is science and what is technology, so that the public does not become confused about the process of scientific discovery with the well-established results of science. Taking wine as the example, he noted that unlike twenty years ago, the quality of wine is now more uniform thanks to technology. A mobile phone too is technology rather than science. “It works. If it were science it would only work one in ten times.”

Vogel’s suggestion was to look at the training, education and selection of future science leaders. “This can change some of the culture of science and that includes getting rid of excellence as the only criterion.”

Ofir reminded the other participants of their Western-centric perspective and urged them to also reflect the situation around other parts of the world.

Sparks for future debate

Moderator Vivienne Parry thanked the participants and welcomed this plethora of suggestions for improving science in future, especially the “banning of the word excellence, slow science, journal of unspectacular results and halving of research papers.” She also reassured participants that they should not feel disheartened by the wide-ranging nature of their discussions. Such a forum, she said, “can spark discussions, which can lead to where we wanted to go.”

List of participants

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