Path2Integrity Campaign

Deliverable D2.2

21 December 2020

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Fundació Catalana per a la Recerca i la Innovació

Path2Integrity

**Rotatory role-playing and role-models
to enhance the research integrity culture**

Prepared under contract from the European Commission

Grant agreement No. 824488
EU Horizon 2020 Research and Innovation action

Project acronym:	**Path2Integrity**
Project full title:	**Rotatory role-playing and role-models to enhance the research integrity culture**
Start of the project:	January 2019
Duration:	36 months
Project coordinator:	Prof. Julia Prieß-Buchheit
	Coburg University of Applied Sciences and Arts
	https://path2integrity.eu
Deliverable title:	Path2Integrity Campaign
Deliverable n°:	D2.2
Nature of the deliverable:	Report
Dissemination level:	Public
WP responsible:	WP2
Lead beneficiary:	Fundació Catalana per a la Recerca i la Innovació
Citation:	López, B., Priess-Buchheit, J. & Surname, I. (2020). *Path2Integrity Campaign*. Deliverable D2.2 EU Horizon 2020 Path2Integrity Project, Grant agreement No 824488.

Due date of deliverable: Month n° 24
Actual submission date: Month n° 24

Deliverable status:

Version	Status	Date	Author(s)
1.0	Draft	01 December 2020	Belén López Fundació Catalana per a la Recerca i a Innovació
2.0	Draft	03 December 2020	Belén López Fundació Catalana per a la Recerca i a Innovació Julia Priess-Buchheit Coburg University of Applied Sciences and Arts
3	Draft	19 December 2020	Jacques Guerette FSST
4	Final version	21 December 2020	Belén López Julia Priess-Buchheit

Subject to change

Table of contents

List of abbreviations

EU   European Union

RI   Research Integrity

R&I   Research and Innovation

Introduction

Science and research are the basis of the technological, social, and cultural progress that characterizes our global civilisation. Citizens' everyday life is, now more than ever, affected by progress in research and innovation. So, research is a key for social progress and carries moral and social values.

Research integrity (RI) is central to safeguarding society's trust and respect in the scientific quest and leads to more efficient, appropriate, useful, and reliable scientific evidence. For this reason, RI is a core common value among the entire scientific and academic research community.

Following that spirit, the Path2Integrity project is dedicated to fostering integrity as an intrinsic value throughout the research and innovation process, using formal and informal learning paths and raising awareness with a widespread campaign.

This report presents the Path2Integrity campaign whose materials and dissemination have been developed to sensitize about the importance of Research Integrity in society. Path2Integrity designed the campaign for different target groups and includes in its dissemination strategy secondary schools as institutions introducing the importance of research in society, as well as universities and their senior researchers representing the top of the system.

1   Path2Integrity's Campaign Vision

Path2Integrity's campaign vision is to represent a research system and community characterised as much as possible by the fundamental principles of research integrity outlined in the European Code of Conduct for Research Integrity (ALLEA 2017): trustworthiness, honesty, respect and accountability. It also considers social misrepresentations, and includes for example gender equality as a principle, because threats to or violations of those principles also endanger research processes.

2   Path2Integrity's Campaign Mission

Path2Integrity's mission is to support a culture of RI, through the re-creation and promotion of innovative teaching methods, by introducing role models and gender equality from early stages of research education in secondary schools, as well as in universities and research communities.

3   Path2Integrity's Campaign Objective

Path2Integrity's campaign aims to raise awareness of the benefits of research honesty and trustworthiness and contributes to establishing a culture of research integrity foremost in the next generation of students and researchers.

For this purpose, different messages, materials, and dissemination actions have been identified, established, and adapted for different target groups.

4   Path2Integrity's Key Target Groups in the Campaign

The campaign's main target audiences are secondary school students, secondary school teachers, undergraduates, and graduates, early and senior career researchers, funding agencies, policy makers, and university administration.

For designing the best tailored campaign, the target audiences have been classified according to three criteria:

- direct or indirect involvement in research activity
- knowledge and interest of the concept of RI
- importance of the campaign aims

Path2Integrity expected different receptions and reactions to the campaign, and adapted the materials design, contents, and the implementation of the dissemination actions accordingly.

Target audience	Involvement in research	Expected attitude towards campaign objective	Importance for achieving campaign aims
Secondary school students	None	Passive	Very high
Secondary school teachers	None	Neutral	Moderate
Undergraduates	Low	Neutral	Moderate
Graduates	Moderate	Active	High
Early career researchers	High	Very active	Very high
Senior career researchers	Very high	Very active	Very high
Funding agencies	Moderate	Very active	Moderate
Policy makers	Low	Neutral	Moderate
University administration	Low	Neutral	Moderate

Table 1: Description of the campaign's target audience

The stakeholders with the most direct involvement in research – early career and senior career researchers – are supposed to welcome the campaign since RI directly affects their professional careers.

In contrast, the rest of the stakeholders, whose involvement in research is less intense or indirect, are supposed to receive the campaign in a neutral or even passive way. For example, many secondary school students consider research to be far from their lives, because their academic curricula often omit research integrity (Häberlein et al. 2019).

That said, Path2Integrity expects no group to reject the campaign outrightly, because they connect to the importance of the issue for society, especially after recent scandals related to scientific fraud (Fanelli 2009, Quin 2017).

Path2Integrity identified that secondary school students are difficult to engage. This group, which Path2Integrity considers incredibly important, perceives research as a distant affair and could receive research integrity with the most indifference. Taking this challenge into account,

Path2Integrity focussed on this group and developed an approach which is as original and appealing as possible.

5 Path2Integrity's Gender Perspective in the Campaign

One of the three main objectives of Horizon 2020's gender equality strategy is to foster gender parity in research and innovation teams and close the gap between men and women's participation. Gender equality is a priority of the European Research Area (ERA), explicated in the Council Conclusions of 1 December 2015 on Advancing Gender Equality in the ERA (General Secretariat of the Council 2015), ensuring gender balance in R&I teams. This is vital to produce high quality outcomes that benefit everybody.

This aspect is addressed in Path2Integrity's campaign by especially-designed messages targeting (future) female researchers, for example by featuring a pregnant scientist on posters. Also, the campaign especially emphasises a balanced female role in research by using outstanding female and male researchers as role models.

6 Path2Integrity's Campaign Key Messages

Taking into account the findings and recommendations of Path2Integrity deliverable D2.1 "Research Integrity portfolio" and the European Code of Conduct for Research Integrity (ALLEA 2017), four key messages were identified and included in the campaign materials in an explicit or implicit way:

1. RI is the quality safeguard of science and technology, the social sciences and humanities

   1.1. It ensures that research design, methodology, analysis and use of resources are properly made
   1.2. It ensures that reporting and communicating research and its results is done transparently, fairly, and without bias
   1.3. It contributes to respect towards colleagues, research subjects, environment, and culture

2. RI protects reputation and careers of researchers and research organizations

   2.1. Following, learning and teaching strict ethical standards in research ensures the trust in researchers' work and results and their social appreciation
   2.2. Assuring that RI principles are followed, learnt and taught in research organizations gives them respectability and credibility, helping to obtain funding

3. RI contributes to social progress, trust and accountability in science and technology, the social sciences, and humanities

   3.1. Good research ensures honesty, respect, accountability, and reliability
   3.2. Good RI practices can minimize bad research and impact

4. RI avoids bad social impacts, waste of money, time, and effort

   4.1. Learning and applying RI avoids serious bad consequences
   4.2. Learning and applying RI ensures that projects are well managed and improves funding success
   4.3. Learning and applying RI ensures that work is accepted and can be used by others

7 Path2Integrity's Campaign Role Models

To give secondary school students and early career researchers orientation and identification, role models from different research fields are at the centre of the campaign. Outstanding researchers were selected by each P2I partner from their own country and invited to participate in the campaign. A gender balance was considered to fulfil the objectives mentioned in chapter 4.1. Table 1 displays Path2Integrity's campaign role models.

Country	Researcher	Discipline	Gender
Spain	Joan Massagué	Medicine	Male
	Ignasi Cirac	Physics	Male
	Marta Macho-Stadler	Mathematics	Female
	Sònia Fernández	Physics	Female
	Samuel Sánchez	Nanorobotics	Male
	Anna Veiga	Biology	Female
	Avelino Corma	Chemistry	Male
Bulgaria	Kristina Bliznakova	Physics	Female
Poland	Tomasz Sulej	Paleontology	Male
	Justyna Olko	Cultural Anthropology	Female
	Bogusława Dorota Gołębniak	Pedagogy	Female
	Tymon Przemysław Zleliński	Oceanology	Male
	Anna Wójcicka	Biology	Female
Germany	Albrecht Beutelspacher	Mathematics	Male
	Alexander Gerber	Information	Male
	Mojib Latif	Oceanography	Male
	Maria Leptin	Biology	Female
	Pauline Schröter	Psycholinguism	Female
Denmark	Philippe Grandejan	Environmental Epidemiology	Male
Kenya	Dorcas Beryl Otieno	Environmental education	Female
Italy	Nanda Rea	Astrophysics	Female

Table 2: Path2Integrity's Role Models

The role models signed a permission according to General Data Protection Regulation (EU GDPR) allowing Path2Integrity to use their images in posters and videos for the Path2Integrity campaign.

8 Path2Integrity's Campaign Materials

The following chapters lay out Path2Integrity's campaign material by describing how Path2Integrity developed the components, by giving an overview on the components, and by describing the various campaign components.

8.1   Development

At first, work package 2 elaborated a campaign strategy and all Path2Integrity partners approved the proposed plan at the end of April 2019 (see milestone MS4). Simultaneously, the team implemented an online survey on research integrity pedagogical practices and training and mapped facts and the state of the art to assist the co-design of the campaign components. At the beginning of July 2019, Path2Integrity organised a workshop in Kiel with representatives from prior SwafS projects to co-design and obtain feedback on the core elements of the campaign. After analysing the results of the actions mentioned above and taking several reports of former Research Integrity EU-funded projects such as ENERI, VIRT2UE and Printeger into account, Path2Integrity produced its first drafts of materials. The team presented them to the partners during the Consortium Meeting 2019, which took place in Brussels.

After this meeting, the Path2Integrity partners gave their feedback and suggestions for improvement in several loops until the Consortium Meeting in Esbjerg in February 2020. For a final review Path2Integrity established a "campaign commission" including Julia Priess-Buchheit, Belén López, Mette Winge, Katharina Miller, and one member of the Path2Integrity International Advisory Board, Jacques Guerette. In March 2020 this "campaign commission" decided on the third drafts of the campaign.

To validate this campaign material, Path2Integrity evaluated some of the messages and images. The evaluation examined how the target audience perceived the last versions and whether the messages are well understood. For this purpose, an international online survey was opened in June 2020 and its results were analysed and incorporated into the final version, which was accomplished in September 2020.

Since September 2020, the final material has been translated into different languages to make the campaign as effective as possible.

8.2   Path2Integrity Campaign Overview

Six elements compose the Path2Integrity campaign: booklets, postcards, posters, leaflets, videos, and thematic overviews (see figure 1).

4 booklets

5 postcards

11 posters

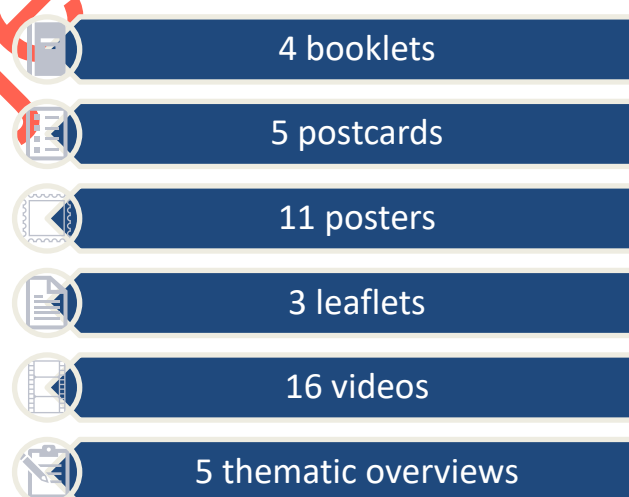3 leaflets

16 videos

5 thematic overviews

Figure 1: Overview Path2Integrity Campaign Material

These elements are adapted for four target groups, which encompass the above-mentioned target audience. Figure 2 shows the Path2Integrity campaign material categorized in four main target groups.

secondary school level	bachelor's and master's degree level	researcher's level	RFO, RPO, and HEI
•1 booklet •5 postcards •1 poster	•1 booklet •1 leaflet •1 postcard •1 poster •16 role-models videos	•1 booklet •1 leaflet •10 posters •16 role-models videos •5 thematic overviews	•1 booklet •1 leaflet •10 posters •Role-models videos

Figure 2: The Path2Integrity Campaign Material in Relation to Four Target Groups

8.3 Path2Integrity Campaign Components

All campaign materials address key issues regarding Research Integrity. The messages in the material are tailored to each target audience by adjusting language, reducing, and transforming information and images. All material use Path2Integrity's corporate colours as well as include Path2Integrity's logo, url www.path2integrity and the EU flag.

Different Research Integrity experts from within the project and external experts such as journalists, schoolteachers, and researchers wrote the various material. (Their names and affiliation are listed in the annex at the end of this document).

8.3.1 Booklets

The Path2Integrity booklets are short publications (between 24 to 48 pages) in English covering all aspects of RI in clear and direct language, accompanied by photos. Path2Integrity created four booklets, each one adapted to its specific target group:

1. Path2Integrity Booklet for Secondary Schools: "Learning Research Integrity at School. The path towards honest research works"
2. Path2Integrity Booklet for graduates and undergraduates: "Promoting good and honest research. How Research Integrity improves research quality"
3. Path2Integrity Booklet for researchers: "Promoting excellence in research. Learning About Research Integrity"
4. Path2Integrity Booklet for organisations: "Creating and Safeguarding Excellent Research Practice. Research Integrity at a glance"

This material will be professionally printed and shipped to each Path2Integrity partner for distribution.

8.3.2 Postcards

The Path2Integrity postcards consist of five different documents in the shape of three postcards, one tryptic and one DIN A-4 sheet. They include short concepts, definitions, statements, and facts with appealing drawings on both sides. Path2Integrity developed them to get students familiar with essential topics for conducting good scientific practice: Respecting authorship, proper citing, using quality sources of information, following the steps of the research process, and expressing concepts correctly.

They are available in English, Bulgarian, Catalan, Danish, German, Polish and Spanish.

8.3.3 Posters

The Path2Integrity posters are eleven DIN A-3 sized sheets with eye-catching image(s) and appealing messages regarding Research Integrity. Six of them are signed by prominent researchers (role models) from Bulgaria (1), Denmark (1), Italy (1), Germany (5), Kenia (1), Poland (5) and Spain (7).

They are displayed in English, Bulgarian, Catalan, Danish, German, Polish and Spanish.

8.3.4 Leaflets

Three Path2Integrity leaflets introduce Research Integrity and its importance for both science and research. The three leaflets share the same text except for a short section calling each target to action:

- Leaflet for graduates and undergraduates
- Leaflet for researchers
- Leaflet for organisations

They are available in English, Bulgarian, Catalan, Danish, German, Polish and Spanish.

8.3.5 Videos with role models

The Path2Integrity videos consist of 16 short interviews with 16 Path2Integrity role models either in English or national languages. The Path2Integrity videos shall inspire future generations and share different aspects and experiences regarding Research Integrity and what it means for society.

8.3.6 Thematic overviews

Path2Integrity designed five thematic overviews. They address the following key themes regarding RI, are six to eight pages-long and target researchers:

- Researcher accountability
- Research environment
- Mentorship in research
- Publishing, reviewing, and editing
- Transparency in research

They are available in English, Bulgarian, Catalan, Polish and Spanish.

9 Dissemination and Channels

The campaign dissemination will officially start in January 2021 and will last till the end of the project. Several teasers in social media will mark the official launch, followed by a press release. The following chapter explains how the Path2Integrity campaign will be disseminated.

For distribution, the Path2Integrity campaign will make use of the Path2Integrity's website, email address lists, the Path2Integrity's social media channels, and ordinary postal delivery.

9.1 Path2Integrity website

A specific webpage named RESEARCH INTEGRITY CAMPAIGN is running within the Path2Integrity's website to view and allow downloads of all Path2Integrity campaign materials. On this webpage the material is classified as follows:

- for secondary school level
- for bachelor's and master's degree level
- for researcher's level
- for research funding organisations, research performing organisations, and higher education organisations

Each of them includes the English and national Path2Integrity campaign material versions. Also, this webpage includes a specific version for home or professional printing (maximum size for keeping good quality: DIN A-3) and a digital version.

9.2 E-mail

Each partner will start a national e-mailing campaign addressed to the different Path2Integrity target groups. Each e-mail will include the Path2Integrity logotype, an introductory text, as well as a link to related materials in their national languages (except in the case of the booklets) and Path2Integrity social media icons.

9.3 Social media

The main objective in the Path2Integrity campaign is to attract our target audiences and engage them in the campaign in an interactive way, thus creating a web of "Research Integrity ambassadors".

The following Path2Integrity social media will be used for dissemination:

- YouTube channel with the interviews with role-models and other project videos
- A Twitter hashtag #MyPath2Integrity
- Facebook
- LinkedIn

Path2Integrity issues tweets, Facebook posts, etc. about the campaign regularly. In parallel, each Path2Integrity partner also disseminates the materials through individual Facebook, Twitter, LinkedIn and YouTube respective accounts.

9.4 Ordinary Post Delivery

To distribute the Path2Integrity campaign on another channel, each Path2Integrity partner receives 200 print copies of the Path2Integrity booklets (50 x 4) and 150 leaflets (50 x 3). These are sent to the Path2Integrity's contacts within universities, research organisations, secondary schools, public administration.

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11 Annex: Campaign materials

4 booklets

Subject to change

Learning Research Integrity at School

The path towards honest research works

Path 2 Integrity

Images: iStock by Getty Images

Path 2 Integrity

www.path2integrity.eu

Subject to change

Learning Research Integrity at School

The path towards honest research works

Content

Introduction

Julia Prieß-Buchheit

Teaching research integrity and academic integrity to students is a challenging and important task. Regardless of whether your students are citizens in a knowledge-based society or whether they are future researchers, research integrity plays a crucial role. For future researchers, research integrity is the cornerstone of their professional career development. For citizens in a knowledge-based society, research integrity is an important signpost for understanding and making use of research results as well as for valuing good research and reliable results.

This booklet gives you ideas on teaching **Research** and **Research Integrity**. Paragraphs of this booklet can be used as learning material.

Research integrity is both highly valuable and worth protecting, because without it, citizens' trust in research inevitably fades, leaving them "vulnerable to misinformation, suspicion and poorly formulated choices"[1]. In the following pages, as part of Path2Integrity (www. path2integrity.eu), authors outline research and how **Research Integrity** is a cornerstone for reliable research results.

The main aim is to explain how important it is for both citizens and (future) researchers to have a culture of research integrity. What is Path2Integrity? Path2Integrity is a European project, funded by the European Commission,that raises awareness about research integrity and educates on how to argue in favour of responsible research and reliable research results.

[1] Science Europe Working Group on Research Integrity (2015): Seven Reasons to Care about Integrity in Research. Online resource: http://www.scienceeurope.org/media/42sphgqt/20150617_seven-reasons_web2_final.pdf. (25.10.2019)

"Research is a quest for knowledge that is conducted in a way that is systematic, calculated, considered, well planned, thought out in advance"[2] and more. What often starts with a hunch, a bit of serendipity, and enduring curiosity leads researchers to build up knowledge, develop technology, inform policy, and solve everyday problems.

Researchers observe materials at a tiny scale as well as deep sea phenomena, light structures from outer space, and much more. Researchers develop theories, like the big bang theory or the theory of relativity. In other words, researchers discover our world and work to understand its meaning. They work in various fields such as natural sciences, humanities, economics or others, where they carry out basic research, develop practical applications, and deepen their knowledge of what they have discovered. They analyse the impacts of climate change, examine the effects of medicines, document difficult diseases, discuss societal rules and educational developments as well as necessities, and look for answers to many more questions. That's right: researchers discover and communicate facts as well as theories about the world. As a result, researchers are an important resource for societies to learn more about themselves and the world they live in.

[2] Prieß-Buchheit, Julia & Haeberlein, Lisa. (2019, September). Learning Card For Research Integrity (S2) (Version 1). Zenodo. http://doi.org/10.5281/zenodo.3383805.

Why is research and research integrity an important topic to teach?

There are many things based on scientific research that students use in their everyday lives without even thinking about it. For example, they take electricity for granted every day when charging phones or cooking meals. When this supply is suddenly unavailable, they become more conscious of how much this resource influences their lives. Although they probably do not explicitly think about Ben Franklin's studies of static and lightning, or about Alessandro Volta's first battery, they are nevertheless reminded of the close relationship between research and society whenever they benefit from the contributions made by researchers like these.

For example, when a student's phone battery runs out during a long train ride and no plugs are available, they may suddenly realise how important electricity and magnetism are as they find themselves hoping that the connecting train has plugs. In these moments, students understand that inventions like these, which are based on reliable research, make life easier and more comfortable.

Research enhances societies' knowledge about the world we live in. Research results filter into society and guide and influence our actions. Look at meteorologists, for instance. They provide reliable tools to accurately forecast weather. Whenever we decide what to wear, we just have a look at what the weather forecast says. If we want to know what to pack in our suitcase for the holidays, whether our desired holiday destination is safe from storms, or what the odds are that a hurricane might threaten our family, meteorology can help us make decisions by providing us with weather reports that are based on scientific insights.

Researchers and their workplace

Whether research is conducted in a reliable manner is in the hands of the researcher as well as their workplace. Researchers' workplaces can greatly vary. Some researchers conduct their research at their desk at home. Others are part of more complex workplaces at universities, laboratories, institutions, etc. One example of an extraordinary research workplace is the CERN institute in Switzerland. To conduct experiments in high energy physics, the CERN built a particle accelerator called a large hadron collider. At 27 kilometres – twice the length of the Ponte Vasco da Gama bridge in Lisbon, Portugal – the large hadron collider represents a very special research workplace. A completely different workplace is the world's largest library for economic literature. The ZBW – the Leibniz Information Centre for Economics in Kiel, Germany – provides economists and related researchers with access to important information and data within their field. These two examples demonstrate that workplaces can greatly influence what researchers do. Furthermore, these workplaces are embedded in larger research systems, as researchers work and collaborate with scientific journals such as Philosophical Magazine or Nature, government and regulatory agencies, funding agencies, and much more. All of these moving parts play important roles in ensuring that research is conducted in a reliable manner.

Teaching the topics of research and research integrity opens a door for your students into our knowledge-based society. Let your students imagine a worst-case scenario: a con artist, posing as a researcher, produces unreliable research results. Eventually, these results make their way into society and can lead to medical mistreatments, the collapse of a car park, or ineffective strategies for crime prevention. No matter which of these consequences occurs, some people will suffer from them – because the con artist clearly and deliberately cheated. Through their research misconduct, the con artist has endangered society. Think about it! Nobody wants a con artist to be a researcher. On the contrary – everybody wants researchers to uphold their research integrity; everybody wants them to work responsibly.

The research process and its application at school

Antoni Chaquet, Sandra Entrena, Neus Sallés i Tenas, Belén López

The research process[1] is used to explore observations and to discover cause and effect relationships by asking questions. It is an iterative process because it involves backing up and repeating to gather and re-examine the evidence. In some sciences, such as social sciences or the humanities, there are other kinds of procedures such as surveys or primary source documentation. The most important outcome of the scientific or research process is the results or a logical answer to the questions proposed: the solution of the research problem.

The main steps in the research process are:

▶ Observing and asking questions

▶ Doing background research

▶ Constructing a hypothesis

▶ Testing the hypothesis by conducting an experiment, performing surveys, and analysing sources or other processes

▶ Analysing data and drawing a conclusion

▶ Communicating results

[1] See the postcards about research process in experimental sciences and 10 steps for writing an academic paper on text-based research on pages 28 to 35

Different research methods require different tools for gathering data[2]:

- ► Quantitative research gathers numerical data which can be ranked, measured or categorised through statistical analysis. It assists with uncovering patterns or relationships and with making generalisations. This type of research is useful for finding out how many, how much, how often, or to what extent.

- ► Qualitative research gathers data about lived experiences, emotions or behaviours, and the meanings individuals attach to them. It assists in gaining a better understanding of complex concepts, social interactions or cultural phenomena. This type of research is useful for exploring how or why things have occurred, interpreting events and describing actions.

- ► Mixed methods research integrates both Qualitative and Quantitative Research. It provides a holistic approach combining and analysing the statistical data with deeper contextualised insights. Using Mixed Methods also enables Triangulation, or verification, of the data from two or more sources.

Usually, this process is written or published as a research paper. It compiles the whole procedure and results and helps to introduce the investigations to be used by others.

[2] Research Methods: What are research methods?: https://libguides.newcastle.edu.au/researchmethods

How to implement the research process in the classroom

Participation in research practices helps pupils to understand how human knowledge is developed, offering a unique opportunity for involving them in processes similar to those produced in research: inquiry, experimentation, modelling, argumentation …

Inquiry-based teaching is the recommended approach for providing these opportunities. This method allows students to explore, research, make conclusions and, ultimately, to communicate what they have learnt.

When implementing it, the following pieces of advice should be considered :

- ► Students should be allowed to directly experience or immerse themselves in the phenomenon or fact they are researching. Outside school, youngsters learn and build concepts from their direct experiences of what surrounds them. The same should happen in the classroom.

- ► Students have to understand that the starting point in their research should be a question. A way to motivate them and make them feel involved in their research is to give them the opportunity to raise that question themselves so that it becomes the most meaningful for them.

- ► To carry out their research, the students must be capable of observing, asking questions, making predictions, designing studies, analysing information, and formulating statements based on evidence. The teachers' task will be to guide them through the whole process.

- ► Far beyond simple experimentation, lessons should not be just about undertaking hands-on experiments but about asking the students to reflect on and discuss what is being produced.

- ► It is necessary to go to other information resources beyond direct experimentation, observation or questionnaires. Books, the Internet or even experts should be consulted to fill the gaps in their research. Even if they choose to search for primary source analysis, they will need to complete it with documentary sources to make a good interpretation.

- ► Bearing in mind that research is a collaborative activity, pupils should work in small groups to share ideas, debate and think with their classmates in the same way professional researchers do.

Handling sources, information and data

The first point for educators to teach students is the type of **information sources**. Primary sources consist of original data (research results or articles, first-hand accounts, diaries, autobiographies, original works, photographs, maps, archive documents, etc.). Secondary sources interpret primary resources (journal articles, books, encyclopaedias, biographies, documentaries, etc).

A second point refers to the origin and the **reliability of information sources**[4]. Nowadays students can access an endless amount of information, but teachers must show them how to assess and select it according to the following criteria:

- ► Credibility (institutions rather than just webpages)

- ► Objectivity (not biased, objective and without a clear point of view. If the source advocates a position, it should provide evidence to support it)

- ► Error-free (check and compare with other resources)

- ► Proper citation of the original source of all supporting information (helping the student to continue their research)

- ► Obsolescence (not too old or with a clear indication of the date of publication)

The third point to address is giving proper credit to all the sources consulted and used during research work. Students must be taught that **acknowledging authorship**[5] is an important part of the research process and that not doing it constitutes a malpractice called plagiarism.

The fourth point is to keep a **proper record and manage the data and results**, highlighting the importance of never making up (fabricating), manipulating or omitting them (falsification) since this would alter the integrity of the whole process and conclusions, constituting a serious transgression.

[3] Guidelines for Adopting Technologies in School (2019): http://steamedu.eu/wp-content/uploads/2019/06/Guidelines-for-Adopting-Technologies-in-School.pdf

[4] See http://bit.ly/postcardfakenews and http://bit.ly/postcardsources

[5] See http://bit.ly/postcardauthorship

Teachers' role

The content investigated should not represent the final objective of applying the research process in school. Rather, the interest lies in transmitting motivation, autonomy, and self-regulation and critical thinking skills.

The teachers' first role is to help the students to organise their ideas, design a good experiment, and obtain good results. Teachers should help them to think, develop critical thinking, let them make mistakes, and guide them in the reconstruction of the process.

The teacher's other role is linked to ethics in research with regard to both the applied method and the studied subject. It is very important to organise debates for students to raise different questions, discuss them, and contrast their opinions. In this way they can be better prepared to become trustful, responsible, and just citizens for the future.

Pedagogical recommendations [6]

Formulate proper questions. Teachers should make sure that the questions that they or their students formulate encourage them to deepen their reasoning, avoiding the queries that can be answered by simple definitions.

Know students' prior ideas. Frequently they already have existing knowledge about certain phenomena, which may be wrong or incomplete. The teachers' task will be to know, complete and rebuild them so that they are scientifically more accurate. For this, it is good to start each new research with debates about what the students think of the issue they are going to research.

Organise group debates so that the students can share their ideas, see different points of view and learn from other classmates. Respecting speaking times, thinking a few seconds before speaking, considering what they mean, or being able to draw conclusions from the debates are skills that must be worked in advance. The teachers' task should be that of the moderator of the debate, allowing the students some autonomy to discuss the topic amongst themselves.

Elaborate final products. It is necessary to create different materials so the students can document their research process and results andthus realise what they have learnt and how. These products can be lab notepads, experiment protocols, oral presentations, or posters. Teachers can consider providing them with models of different products so that they can learn to make them.

[6] Guidelines for Adopting Technologies in School (2019): http://steamedu.eu/wp-content/uploads/2019/06/Guidelines-for-Adopting-Technologies-in-School.pdf

The research process in 10 steps

Experimental Sciences

1. Observation
The observation of any phenomenon is the first step when you plan any research. Observe the events and phenomena occurring around you.

2. Research question or initial hypothesis
Once you have observed a phenomenon you must propose a well-focused research question. To answer it is the aim of the research process.

3. Exploration
Search for any appropriate and relevant background information related to the phenomena you are researching to enhance the understanding of the context.

4. Definition of variables
Identify the variables playing a role in your research. You must define the independent, dependent and controlled ones.

5. Experimentation
Establish an appropriate methodology to address the research question. You must take measurements of different variables and collect data.

6. Analysis
Analyse the qualitative and/or quantitative collected data to support detailed and valid conclusions to the research question. Data could be processed and shown as graph, tables, statistics...

7. Conclusions
Extract your conclusions about your experimentation and the collected data after making the analysis.

8. Evaluation
Evaluate the research question or the initial hypothesis by using your conclusions. You must check whether the conclusions of your results fit the research question or the initial hypothesis. If so, you can move to the following step. If not, you must modify the research question or the hypothesis, and start again on step 2. When a hypothesis is widely supported it could reach the status of a theory.

9. Improvements, suggestions and extension
Your research has not finished yet. Propose suggestions for the improvement and the extension of your research that can help future research and other researchers.

10. Communication
Your research is not finished until you publish it by writing a paper, or scientific report, and disseminating it through scientific journals, a website, social media, etc... To assess its validity, quality and originality it will be first reviewed by specialists in the same research area in a process called "peer review".

Don't forget to mention all the sources and authors consulted to help you with your work.

Author:
Jordi Mazón Bueso

10 Steps for Writing an Academic Paper on Text-based Research

Getting started: what would you like to research?

1

Identify an issue, problem, or topic in a particular field of study that appeals to you personally. Then try to express your interests – as an exciting question – or as a bold statement.

Find basic background information

2

Look for credible sources of information: written interviews, letters, films, books, photographs or other artefacts. Use library catalogues and online resources. Take note of any references suggesting that someone else is working on your issues. If there are many others, consider rephrasing your question or statement to narrow your focus or to take a wider view.

Define your research approach

3

Decide more specifically how you want to answer your question.

You can:

- explore the issues in depth;

- analyse, classify, and interpret the data produced by others;

- pick an option and compareit to those advanced by other people, evaluating the pros and cons;

- or merge the findings and arguments from many sources to suggest new options and ways of seeing the issue.

Whatever approach you chose, you must justify it with reasons that are convincing, rational, and understandable.

Formal literature review

4

Think of key words that define your question and look for matching indexes and abstracts using search engines such as Google Scholar, Semantic Scholar and Microsoft Academic. Look for references that can help you with your reasoning and plans for making your argument.

Assess and review sources of information

5

You will find more sources of information than you can possibly review or need, so review what you have found and keep those that

• are unbiased and accurate;

• recognise the status quo and existing evidence;

• are produced by authors and organisations with relevant expertise;

• contain an original statement (i.e. from the original source) or explain something better (i.e. from a secondary source)

Seek more sources of information if needed and assess against the above.

Confirm your approach and line of argument

6

In light of this information, ask yourself whether your question still seems valid and whether it points towards new knowledge. Check if your approach can be justified with reasons that are convincing, rational and understandable.
If not, go back to Step 1 or 3.

Outline and then write your paper

7

Create an outline of the academic paper you intend to produce. You can search for models online. Then write your paper.

Organise information sources in a discipline-appropriate format

8

Look up how to cite information in the discipline related to your issue. In every discipline, researchers need to know the accepted techniques for direct and indirect quotes as well as for summaries.

Create an alphabetical list of the sources of all of the important information you used. Organise this in the References section at the end of your paper.

Give your paper to a respected friend

9

Share your paper with a trusted friend who can give honest and constructive feedback. Ask them to check your line of argument, spelling and grammar.

Hand in your paper

10

After you have revised the manuscript, considered your friend's feedback and checked your citations, bibliography and line of argument one last time, hand in your paper to your teacher, lecturer or to the editor of a scientific journal.

www.path2integrity.eu

Authors:
Julia Prieß-Buchheit and Dick Bourgeois-Doyle

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Cf. Washington University St. Louis: https://libguides.wustl.edu/researchapproaches

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Path 2 Integrity

Promoting Good and Honest Research

How Research Integrity improves research quality

Path 2 Integrity

Subject to change

Promoting Good and Honest Research

How Research Integrity improves research quality

Subject to change

Images: iStock by Getty Images

Path 2 Integrity

www.path2integrity.eu

Content

Introduction

Julia Prieß-Buchheit

"Research is a quest for knowledge that is conducted in a way that is systematic, calculated, considered, well planned, thought out in advance"[1] and more. What often starts with a hunch, a bit of serendipity, and enduring curiosity leads researchers to build up knowledge, develop technology, inform policy, and solve everyday problems.

Researchers observe materials at a tiny scale, as well as deep sea phenomena, light structures from outer space, and much more. Researchers develop theories, like the big bang theory or the theory of relativity. In other words, researchers discover our world and work to understand its meaning. They work in various fields such as natural sciences, humanities, economics or others, where they carry out basic research, as well as practical application and further development of what they have discovered. They analyse the impacts of climate change, examine the effects of medicines, document difficult diseases, discuss societal rules and complex generation structures, and look for answers to many more questions. That's right: researchers discover and communicate facts about our

world. As a result, researchers are an important resource for societies to learn more about themselves and the world they live in.

Now, imagine a worst-case scenario: a con artist, posing as a researcher, produces unreliable research results. Eventually, these results make their way into society and can lead to medical mistreatments, the collapse of a car park, or ineffective strategies for crime prevention. No matter which of these consequences occurs, some people will suffer from them – because the con artist clearly and deliberately cheated. Through their research misconduct, the con artist has endangered society. Think about it! Nobody wants a con artist to be a researcher. On the contrary – everybody wants researchers to uphold their research integrity; everybody wants them to work responsibly.

That is why this booklet explains in depth that **Research Integrity** is of the utmost importance for both researchers and for society. Research Integrity is valuable and worth protecting, because without it, citizens'

[1] Prieß-Buchheit, Julia & Haeberlein, Lisa. (2019, September). Learning Card For Research Integrity (S2) (Version 1). Zenodo. http://doi.org/10.5281/zenodo.3383805.

trust in research inevitably fades, leaving them "vulnerable to misinformation, suspicion and poorly formulated choices"[2].

In the following pages, as part of Path2Integrity (www.path2integrity.eu), authors outline how Research Integrity is a cornerstone of reliable research results. The main aim is to explain how important it is both for you as a citizen and for you as a (future) researcher to have a culture of research integrity. What is Path2Integrity? Path2Integrity is a European project, funded by the European Commission, that raises awareness about Research Integrity and educates on how to argue in favour of responsible research and reliable research results.

So, what is important for researchers and citizens again?
Researchers are reliable, meaning that we can trust in them.

- ▸ Researchers do not lie; they are honest.

- ▸ Researchers do not cause harm; they respect everyone and everything.

- ▸ Researchers do not act irresponsibly; they are accountable[3].

[2] Seven Reasons to Care About Integrity in Research. Science Europe: https://www.scienceeurope.org/our-resources/seven-reasons-to-care-about-integrity-in-research/

[3] See ECoC, 2017, p.4.

Why is research important to us?

There are many things based on scientific research that we use in our everyday lives without even thinking about it. For example, we take electricity for granted every day when we charge phones or cook meals. When this supply is suddenly unavailable, we become more conscious of how much this resource influences our lives. Although we probably do not explicitly think about Ben Franklin's studies of static and lightning, or about Alessandro Volta's first battery, we are nevertheless reminded of the close relationship between research and society whenever we benefit from the contributions made by researchers like these.

For example, when your phone battery runs out during a long train ride and no plugs are available, you may suddenly realise how important electricity and magnetism are as you find yourself hoping that the connecting train has plugs. In these moments we understand that inventions like these, which are based on reliable research, make life easier and more comfortable.

Research enhances our knowledge about the world we live in. Research results filter into society and guide and influence our actions. Look at meteorologists, for instance. They provide reliable tools to accurately forecast weather. Whenever we decide what to wear, we just have a look at what the weather forecast says. If we want to know what to pack in our suitcase for the holidays, whether our desired holiday destination is safe from storms,

or what the odds are that a hurricane might threaten our family, meteorology can help us make decisions by providing us with weather reports that are based on scientific insights.

Whether research is conducted in a reliable manner is in the hands of the researcher as well as their workplace. Researchers' workplaces can greatly vary. Some researchers conduct their research at their desk at home. Others are part of more complex workplaces at universities, laboratories, institutions etc. One example of an extraordinary research workplace is the CERN institute, in Switzerland[3]. To conduct experiments in high energy physics, the CERN built a particle accelerator called a large hadron collider. At 27 kilometres – twice the length of the Ponte Vasco da Gama bridge in Lisbon, Portugal – the large hadron collider represents a very special research workplace. A completely different workplace is the world's largest library for economic literature. The ZBW – the Leibniz Information Centre for Economics[4] in Kiel, Germany – provides economists and related researchers with access to important information and data within their field. These two examples demonstrate that workplaces can greatly influence what researchers do. Furthermore, these workplaces are embedded in larger research systems, as researchers work and collaborate with scientific journals such as Philosophical Magazine or Nature, government and regulatory agencies, funding agencies, and much more. All of these moving parts play important roles in ensuring **Research Integrity**.

[3] https://home.cern/

[4] http://www.zbw.eu/en/

Sources of information and data

Dolors Grillo Bosch

1. Prior to starting any written piece of work you should think about these questions:

- ▶ What is my area of expertise and speciality?

- ▶ What kind of work do I want to do?

- ▶ What do I know about this topic?

The answer will determine what and where to look for information. For instance, the information sources might not be the same for humanities as for biology, or they could differ according to whether you are going to write a monograph, a review or an original piece of work.

2. In order to prepare a new piece of work you also need to know what kind of sources of information there are in order to define what to look for.

The sources of information can be classified as:

Primary information source: the source where the new and original research findings and theories are made public, such as research journals or conferences, including their proceedings and publications.

Secondary information source: the information source that in general is an analysis of the original research findings and theories described in the primary sources. Examples of secondary sources are books, encyclopaedias, and reviews.

Tertiary information sources: a list of facts and key information items such as dictionaries, encyclopaedias or other reference material.

3. To determine where to look for information you should first:

- Ask your teacher or supervisor for advice. He or she is an expert on how to prepare different pieces of work for a given research area.

- Check the library or the library website of your school, college or university. Library staff are professionals who know the library and the different kinds of information sources you could be interested in.

4. Sources of information and their quality: Depending on the aims of your work, good sources of information can include:

Books, textbooks and monographs: These kinds of sources, in general, provide an in-depth overview of a subject. In general, they include a lot of references, which can be good if the topic you are writing about is new for you.

Journal articles: This type of information resource includes original research papers and reviews. The first provide emerging research results. Reviews are also really good sources of information, as in general they assemble, comment and give a perspective on what has been done and what will or must be done on a hot research topic. When looking for Journal articles you should take into account that there are two different kinds of journals in terms of the availability of their articles: some are fully open access, and you will be able to read all the articles whenever and wherever you want, e.g. eLIFE or PLOS ONE, while for others you will only be able to access the article if its authors have paid a fee for being open, which is already the case for many journals.

Dissertations and their repositories: This is first-hand information on what is carried out in research at a given moment. In general, they also contain a good review of information on a given topic. Right now, there are plenty of repositories that either contain a summary of the thesis or even a PDF file of the whole document.

Technical reports and Patents: These are technical documents that also contain information that could be relevant for some pieces of work. There are international patent offices such as the European Patent Office (EPO) and World Intellectual Property Organization (WIPO), and national ones such as the OEPM in Spain. In general, each country has its own patent office.

In order to search for the aforementioned documents and be aware of the quality of the research journals, you should take into account that there are **specific databases, some of them open, others partially open and other available just by subscription.** You can access these databases via the Internet.

The quality of the journals is evaluated in databases such as the Web of Science and its Journal Citation Reports (appearing each year) and by scientometric indexes such as the Impact Factor. Carhus Plus, ERIH PLUS and ANVUR are also good tools to evaluate the quality of the journals in Social Sciences and Humanities.

There are specific databases such as PubMed and the European EUROPE PMC for Life Sciences that provide access to at least abstracts for many of the aforementioned information sources.

Pieces of advice

- The Internet and Wikipedia are great tools and in some cases they can provide a starting point. However, they also contain information that is unreliable (for instance there are doubts about the authorship, the author affiliation is not known, the information obtained is not updated, among others) and too lax. Thus, frequently starting with these tools in your academic or professional works is a bad decision.

- Defining a good search strategy in databases can save time and provide better quality results on your searches.

Section 2, 3 and 4

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5. Citing the information sources

Properly citing your sources is a fundamental part of your work. We provide some indications in the References section that can be useful for doing this part of your work properly.

6. Some final general remarks

Before using the information you found in the paper you want to write, you should answer the following questions yourself:

► Is this information that I easily found relevant for the paper I want to write?

► Does this information I easily found have enough quality to be used in the paper I want to write?

► Is the information I found valid enough for the paper I want to write?

► Does the information I gathered have any bias that lowers the quality of the paper I want to write?

Finally, have you been honest about the paper you wrote?

► Have you used appropriate information sources?

► Are the information sources you used of good quality?

► Have you correctly cited all the sources used?

► Have you actually written the paper by yourself?

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What is research integrity and why is it important?

Arja R Aro, based on ALLEA: The European Code of Conduct for Research Integrity, revised edition.

What is research?

Research can be understood as a systematic and transparent way to gain knowledge. Knowledge is needed to understand our world, develop technology such as robots, treatments for diseases, or ways to protect the environment. Thus, research is very important to society. Research needs to be trustworthy and carried out transparently. Research knowledge is not only about technology and science; it also needs to consider individual, community, and cultural values. New technology based on research (e.g. self-driving cars) needs to be carefully evaluated to decide if, where and how it could be used to serve humankind instead of causing additional harm.

Different stakeholders of research

Researchers are not fully independent in their work. Those who finance research (e.g. industry, ministries giving money) have the power to decide which research topics are studied. Research can be done in humans, animals, or the environment; integrity means that they all need to be treated with respect and harm should be avoided. Further, researchers need to respect each other. Most societies have established research integrity or research ethics committees to safeguard research quality.

Principles of research integrity

The central principles of research integrity are reliability, honesty, respect, and accountability[1]. Reliability means that the research is done well, with a proper research design, relevant methods, good data analysis, and rational use of resources. Honesty means that research is planned and done, evaluated and communicated transparently, fairly, and without biases. Respect covers colleagues, research participants, the society, ecosystem, culture and environment. Accountability (=responsibility) covers the research process from conception to publication, management and organisation, training, supervision and mentoring juniors, and managing the wider impact of research.

Good research practices

The research environment should value integrity and deal with violations to good research practice. When research material and management are well organised, research can be reproduced. Training, supervision, and mentoring should aim at good and rigorous research process and methods, relevant integrity and ethics regulations and codes, and it should involve researchers, leaders, supervisors and mentors.

[1] The European Code of Conduct for Research Integrity https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

Research procedures need to be based on what is known about the topic already. Careful research process uses resources reasonably, publishes results with correct interpretations, respects the confidentiality of the information, and follows relevant reporting guidelines[2].

Safeguards cover relevant regulations and codes and deals with research subjects (human, animal, cultural, biological, environmental, physical) with respect and care; considers the health, safety and welfare of the community and collaborators; and is sensitive to age, gender, culture, religion, ethnic origin, and social class.

Data practices and management need to ensure transparency and access to data 'as open as possible, as closed as necessary' and be FAIR (Findable, Accessible, Interoperable, Re-usable) as well as to respect the intellectual property rights (IPR) of research outputs. In Europe, new regulations have been produced for data protection[3].

Collaborative working means that all partners take responsibility for research integrity, agreeing on the goals and the need for open communication; on following codes, laws and regulations; and on handling conflicts. All partners are informed and consulted about submitting the research report for publication.

Publication and dissemination: All authors are fully responsible for the content of research publications (unless otherwise stated).

Author order is agreed together; authorship needs to based on significant contributions to the design, data collection, analysis, and interpretation of results.
Generally, results should also be openly communicated to the general public both in traditional and social media. All collaborators, funders, and assistants need to be acknowledged; conflicts of interest need to be declared. Negative results (meaning e.g. that the intervention studied did not work) are as valid as positive ones.

Reviewing, evaluating and editing: Researchers take seriously their commitment in refereeing, reviewing, and evaluating research manuscripts, funding or job applications, promotions, and rewards; they carry out these tasks transparently and justifiably, declaring a conflict of interest when relevant.

Violations of research integrity

Failing research integrity and good practices means renouncing one's professional responsibilities; it damages the research process, degrades relationships between researchers, undermines the trust and credibility of research among people and society, wastes resources, and may also bring danger or even harm to research participants, users, the society, or the environment.

Research misconduct and unacceptable practices

Misconduct can happen in writing a research plan, doing research, reviewing it, or reporting it. Fabrication means making up results and presenting them as real. Falsification is manipulating research material, equipment, or the process, or changing, leaving out data or results without justification. Plagiarism happens when someone uses other people's work and ideas without giving proper credit (=referencing) to the original sources, thus violating the IPR of the original authors.

Dealing with violations and allegations of misconduct

Violations need to be dealt with transparently and consistently, considering integrity and fairness. Integrity means that investigations of suspected misconduct are fair, confidential, comprehensive and quick. Investigations should be accurate, objective and thorough. Conflicts of interest need to be declared; conclusions should be reached; and whistle blowers need to be protected. Further, the procedures for dealing with violations need to be publicly available and accessible to ensure their transparency and uniformity.

Fairness means that the process is fair to all parties; those accused of misconduct are given full details of the allegations and allowed a fair process for responding to allegations and presenting evidence. Action to those shown to have participated in misconduct has to be proportionate to the severity of the violation. Appropriate restorative action is taken when researchers are freed from suspected misconduct. It needs to be remembered that anyone accused of research misconduct is presumed innocent until proven otherwise.

[2] Reporting guidelines: example: Enhancing Quality and Transparency of Health Research https://www.equator-network.org/about-us/what-is-a-reporting-guideline/

[3] General Data Protection Regulation (GDPR) https://gdpr-info.eu/

The Open Scientific Career

Jordi Mas-Castellà

We all agree that the modern scientist is made, not born. Thus the main features of scientific work, such as the generation, maintenance, transmission and authority of knowledge can be learnt and mastered. We cannot doubt that scientific research is a social activity and, in order to understand it, special emphasis should be placed on how scientists behave towards one another, how they are organised and how information passes between them. Scientists form part of a community that is auto regulated since its members have to participate in the approval of other scientists' research output (by accepting manuscripts to be published in scientific journals that are added to the author's curriculum vitae), on the boards that hire or fire scientists for different positions, on the committees that rank research proposals or grants, etc. As an academic community, however, it needs to become more articulate, persuasive and influential in holding up the values of science and the leadership that this requires, in all its forms[1]. Some authors may think that scientists are internally motivated, dedicated, even called, to their work; they are selfless, resistant to convention and authority, intentionally blind to social convention and prejudice, unconcerned for fame and material reward, open[2].

The Open Science movement has been unfolding intensely over the past years to improve the credibility and reproducibility of science. Key domains of Open Science practices include Open Data; Open Source; Open Notebook; Open Access; Open Peer Review; Open Education; and citizen science (involving the general public in scientific research). Open Science aims to make scientific data and research accessible to all levels of an inquiring society. We should then include the personal endeavour of a scientist (their science career) in this same movement and assess the career of a scientist as an Open Scientific Career.

[1] Steelman, T. A., & McDonnell, J. J. (2017). *Look for the leaders*. Nature. https://doi.org/10.1038/nj7664-483a

[2] Shapin, S. (2008). *The Scientific Life: a moral history of a late modern vocation*. Chicago: The University of Chicago Press.

Scientific careers should be Open, in the broadest sense of the term. Besides Open Science, Open Innovation defines the multiple paths of knowledge going from academia to companies, to users and back. In this context, science careers should also be open, meaning that scientists should have the skills to succeed in different working environments. Programmes that facilitate the contact and transit between the academic and business worlds are now usual. Flexibility of working conditions, hiring requirements, and different types of job agreements should allow the positive flow of scientists to the companies' labour market. This, however, is not an easy task, since the science community and the business community still have their own standard rules. Ostensibly doctoral graduates secure better employment than those with only an undergraduate degree, enjoying a higher employment rate, more highly skilled work, increased earnings and a reduced gender pay gap[3]. For instance, some studies show that most postdocs will not find tenure-track positions within universities, while postdoctoral fellowships are viewed as positions that prepare PhD students for academic careers. Postdocs consequently pursue non-academic jobs that differ in the degree to which they utilise postdoctoral scientific training. Multiple individual, principal investigator (PI), as well as organisational and policy factors, including

the lack of relevant skills, absence of support—and in some cases opposition—from their PIs, and poor availability of non-academic career preparation opportunities, influence scientists' transition to non-academic careers. Viewed collectively, these elements likely hinder a move to non-academic scientific positions and thus have consequences for postdoc career trajectories and, by extension, the utilisation of new knowledge[4].

An Open Scientific Career implies that all decisions taken should be strategic. The scientific career should be goal oriented, planning for and addressing the researcher's own objectives. An internal analysis of our personal strengths and weaknesses should precede the external assessment of the opportunities out there. The alignment of personal assets with foreseen objectives and milestones should be carried out in a strategic way. For example, changing institutions is a key career decision for scientists, playing an important role in education, scientific productivity, and the generation of scientific knowledge. Some authors affirm that a scientist's profile determines their decision to move (i.e., change institution). Their recent scientific career, the quality of their scientific environment, and the structure of their scientific collaboration network influence to a high degree the next researcher's move and which institution they will choose[5].

[3] Hancock, S. (2017). *Who gets what? Understanding UK doctoral degree outcomes in terms of graduates' background characteristics and prior higher education experience*. Retrieved from https://www.srhe.ac.uk/downloads/reports-2016/HANCOCK-Sally-SRHE-NR-Final-Report.pdf

[4] Hayter, C. S., & Parker, M. A. (2019). *Factors that influence the transition of university postdocs to non-academic scientific careers: An exploratory study*. Research Policy, 48(3), 556–570. https://doi.org/10.1016/j.respol.2018.09.009

[5] James, C., Pappalardo, L., Sîrbu, A., & Simini, F. (2018). *Prediction of next career moves from scientific profiles*. ArXiv: 1802.04830v1. Retrieved from https://arxiv.org/pdf/1802.04830.pdf

Stating the obvious, an Open Scientific Career should be international. Even though in some cases the research focus has some local aspect to deal with, the general scope and the interrelations with others have to be in the international context. In this respect, mobility programmes are extremely important, allowing scientists to stay for short or long periods of time with groups in other countries. These programmes help to reinforce (for the hosting lab and for the visitor) the social dimension of the scientific activity. Special emphasis should be placed on links to science in developing countries. As Mirjana Povic states[6]: "More scientists should consider sharing their experience and knowledge in developing countries ... You can make huge personal and professional progress by going outside your normal routine and comfort zone. You learn many things when you adapt to different conditions ...This life isn't easy. But scientists can adapt and find ways to get things done. We learn new ways to do things and discover patience that we didn't know we had. That comes in handy in many areas of life."

Finally, the Open Scientific Career has to be ethical. The scientist's behaviour and activities have to be respectful of oneself, others, and the environment. And knowledge is called on to play an essential role. As Hans Jonas[7] states: "No previous ethics had to consider the global condition of human life and the far-off future,

even existence, of the race ... Knowledge, under these circumstances, becomes a prime duty beyond anything claimed for it heretofore, and the knowledge must be commensurate with the causal scale of our action."

Science may err, but it is, after all, self-correcting. And similarly, the Open Scientific Career may err, but adaptation and redirecting is an intrinsic part of it.

[6] Dance, A. (2018). *Meet the space researcher smoothing the path for women in science across Africa.* Nature, 563(7729), 148. https://doi.org/10.1038/d41586-018-07198-z

[7] Jonas, H. (n.d.). *Technology and Responsibility: Reflections on the New Tasks of Ethics | Inters.org.* Interdisciplinary Encyclopedia of Religion and Science. Retrieved 7 September 2020, from http://inters.org/jonas-technology-responsability

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Content

Introduction

Julia Prieß-Buchheit

With thanks to Lisa Häberlein and Oliver Claas

Lack of knowledge on how to produce reliable research results and how to manage breaches of integrity in the process of conducting research studies are the two reasons why research misconduct appears. In the last decades, the research community has encountered severe cases of both misconduct due to lack of knowledge and through breaches of integrity. These cases revealed that some researchers commit fraud by plagiarising texts, data and graphics; falsifying research materials; tampering with equipment; or fabricating research results. They may also fail to know specific research procedures, habits, or standards.

Furthermore, evidence indicates that research misconduct is a more widespread phenomenon than these severe cases would indicate[1]. "Failing to follow good research practices violates professional responsibilities. It damages the research processes, degrades relationships among researchers, undermines trust in and the credibility of research, wastes resources and may expose research subjects, users, society or the environment to unnecessary harm"[2].

Of course, there are various views about what research integrity stands for. For the purpose of starting a dialogue on what research integrity means within the research environment, the following characterisation can stimulate discussion: "Researchers with research integrity produce results that society can rely on. Researchers with research integrity are able to explain step by step how they arrived at their research results. Furthermore, the results should be reproducible by others … Researchers are both supported by and observed within their research environment. Some people specialise in observing and advising to keep research reliable and trustworthy. Their tasks are outlined in research ethics commissions policies, codes for good scientific practice, task descriptions of ombudspersons, declarations of data protection etc."[3]

[1] See Fanelli, D. (2009) How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-Analysis of Survey Data. PLoS ONE 4.5, e4738, pp. 1–11.

[2] ALLEA – All European Academies (2017) The European Code of Conduct for Research Integrity, Revised Edition, Berlin, p.8.

[3] See Priess-Buchheit, Julia, & Haeberlein, Lisa. (2019, September). Learning Card For Research Integrity (S1) (Version 1). Zenodo. https://doi.org/10.5281/zenodo.3383671.

Why is Research Integrity important for you?

As pointed out by the Science Europe Working Group, there are seven reasons why you should emphasise research integrity[4]:

1. Research Integrity Safeguards the Foundations of Science and Scholarship

2. Research Integrity Maintains Public Confidence in Researchers and Research Evidence

3. Research Integrity Underpins Continued Public Investment in Research

4. Research Integrity Protects the Reputation and Careers of Researchers

5. Research Integrity Prevents Adverse Impacts on Patients and the Public

6. Research Integrity Promotes Economic Advancement

7. Research Integrity Prevents Avoidable Waste of Resources.

To cope with knowledge gaps and breaches of integrity, the research community has combined forces in prevention, education, awareness raising, and sanctioning, for example by developing and spreading learning materials and campaigns, involving ombudspersons, publishing codes of conduct and generating procedures for misconduct investigations. In the last decades the research community took over their responsibility to an increasing degree, fostering these and other actions (especially the ones tackling breaches of integrity) under the umbrella of Research Integrity, and emphasised the features of reliable research results, excellence, and trustworthiness. From an educational perspective these actions for research integrity set significant benchmarks.

In the following pages, as part of Path2Integrity (www.path2integrity.eu), authors outline some of the benchmarks of Research Integrity. What is Path2Integrity? – Path2Integrity is a European project, funded by the European Commission, that raises awareness about research integrity as well as providing education on how to argue in favour of responsible research and reliable research results. Path2Integrity offers two approaches supporting research integrity. Using Path2Integrity's learning cards, (future) researchers can develop competencies to avoid misconduct and to stand for excellent research practice themselves. Meanwhile, Path2Integrity's campaign materials can help research organisations raise awareness on research facts about research integrity and role models.

[4] Headlines from: Seven Reasons to Care about Integrity in Research, from the Science Europe Working Group on Research Integrity (2015) Online resource: https://www.scienceeurope.org/media/42sphgqt/20150617_seven-reasons_web2_final.pdf. (accessed 28 November 2019)
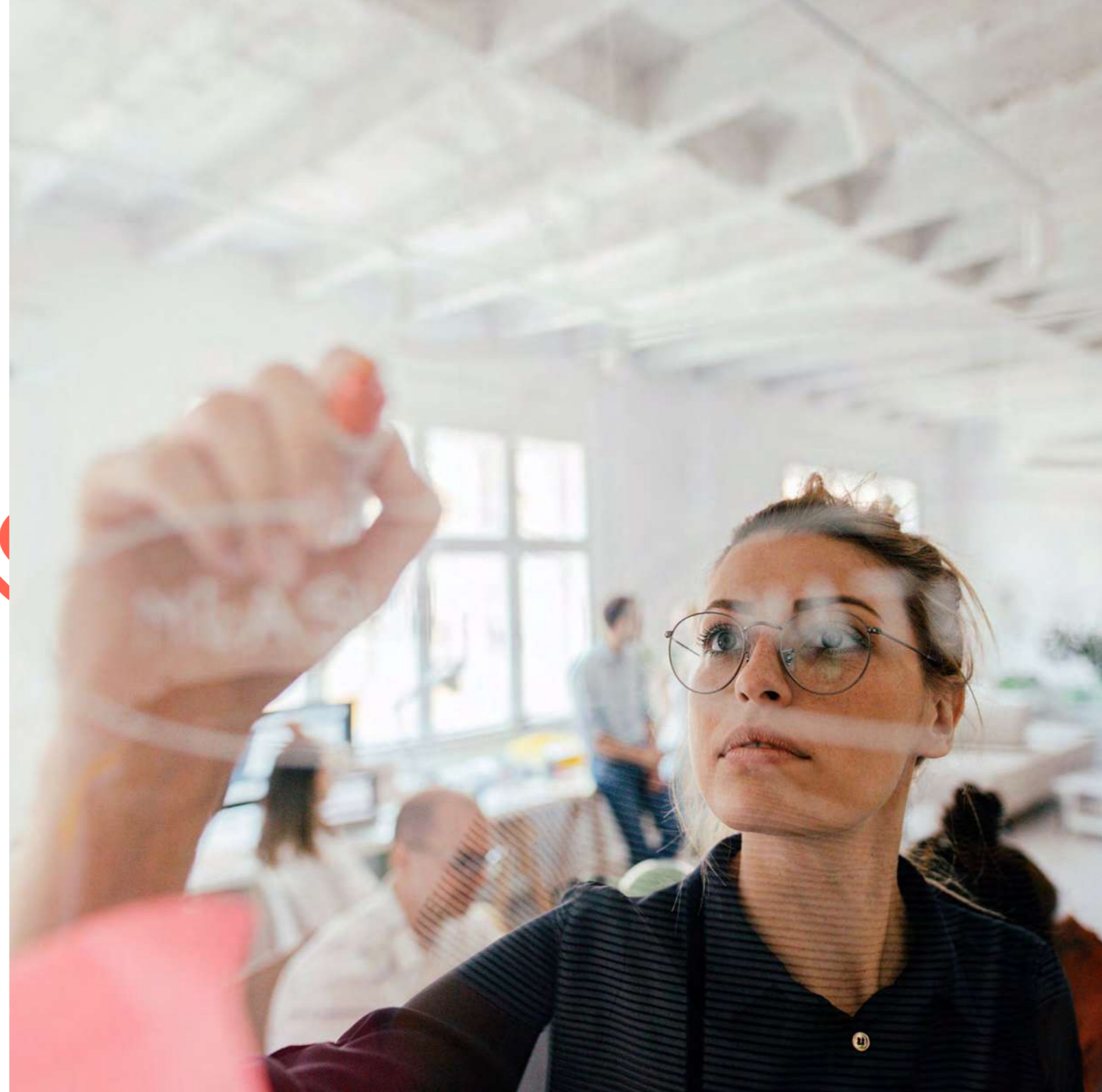
What are researchers' obligations in research integrity?

While the broader research environment has significant influence on whether research is conducted in a reliable manner, it is also very much in the hands of researchers throughout the span of their career. In large research systems comprised of researchers, scientific journals, government, regulatory agencies, funding agencies, and more, every stakeholder has an influence on whether research is conducted responsibly.

Researchers' obligations can be manifold here. This booklet emphasises the following two contexts, because they are at the core of Path2Integrity's project:

1. Both early career researchers and experienced researchers conduct their research in a responsible manner to achieve reliable results;

2. In a research community, experienced researchers and early career researchers are both role models for others, especially for students, and lead them with integrity.

The following quote from the European Code of Conduct gives early career researchers orientation and reminds experienced researchers which fundamental principles guide good research practice:

▸ "Reliability in ensuring the quality of research, reflected in the design, the methodology, the analysis and the use of resources.

▸ Honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair, full and unbiased way.

▸ Respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment.

▸ Accountability for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts"[5].

So, what are researchers' obligations in ensuring research integrity? How do researchers actively tackle breaches of integrity, such as fabrication, falsification and plagiarism, as well as lack of knowledge in practice? They tackle both breaches of integrity and lack of knowledge by teaching future researchers, mentoring their employees, carefully reviewing data sets and articles, adequately responding to accusations, and much more. All these different approaches foster reliable research results.

With this booklet we actively want to tackle breaches of integrity by inviting both early career researchers and experienced researchers to explicitly argue in favour of responsible research conduct and reliable research results. Let us start to foster a culture of research integrity.

[5] ALLEA – All European Academies (2017) The European Code of Conduct for Research Integrity, Revised Edition, Berlin, p. 4.

What is research integrity and why is it important?

Arja R Aro, based on ALLEA: The European Code of Conduct for Research Integrity, revised edition.

What is research?

Research can be understood as a systematic and transparent way to gain knowledge. Knowledge is needed to understand our world, develop technology such as robots, treatments for diseases, or ways to protect the environment. Thus, research is very important to society. Research needs to be trustworthy and carried out transparently. Research knowledge is not only about technology and science; it also needs to consider individual, community, and cultural values. New technology based on research (e.g. self-driving cars) needs to be carefully evaluated to decide if, where and how it could be used to serve humankind instead of causing additional harm.

Different stakeholders of research

Researchers are not fully independent in their work. Those who finance research (e.g. industry, ministries giving money) have the power to decide which research topics are studied. Research can be done in humans, animals, or the environment; integrity means that they all need to be treated with respect and harm should be avoided. Further, researchers need to act inclusively and respect each other. Most societies have established research integrity or research ethics committees to safeguard research quality.

[1] The European Code of Conduct for Research Integrity https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code_of_conduct_en.pdf

Principles of research integrity

The central principles of research integrity are reliability, honesty, respect, and accountability[1]. Reliability means that the research is done well, with a proper research design, relevant methods, good data analysis, and rational use of resources. Honesty means that research is planned and done, evaluated and communicated transparently, fairly, and without biases. Respect covers colleagues, research participants, the society, ecosystem, culture and environment. Accountability (=responsibility) covers the research process from conception to publication, management and organisation, training, supervision and mentoring juniors, and managing the wider impact of research.

Good research practices

The research environment should value integrity and deal with violations to good research practice. When research material and management are well organised, research can be reproduced. Training, supervision, and mentoring should aim at good and rigorous research process and methods, relevant integrity and ethics regulations and codes, and it should involve researchers, leaders, supervisors and mentors.

Research procedures need to be based on what is known about the topic already. Careful research process uses resources reasonably, publishes results with correct interpretations, respects the confidentiality of the information, and follows relevant reporting guidelines[2].

Safeguards cover relevant regulations and codes and deals with research subjects (human, animal, cultural, biological, environmental, physical) with respect and care; considers the health, safety and welfare of the community and collaborators; and is sensitive to age, gender, culture, religion, ethnic origin, and social class.

Data practices and management need to ensure transparency and access to data 'as open as possible, as closed as necessary' and be FAIR (Findable, Accessible, Interoperable, Re-usable) as well as to respect the intellectual property rights (IPR) of research outputs. In Europe, new regulations have been produced for data protection[3].

Collaborative working means that all partners take responsibility for research integrity, agreeing on the goals and the need for open communication; on following codes, laws and regulations; and on handling conflicts. All partners are informed and consulted about submitting the research report for publication.

Publication and dissemination: All authors are fully responsible for the content of research publications (unless otherwise stated). Author order is agreed together; authorship needs to based on significant contributions to the design, data collection, analysis, and interpretation of results.

Generally, results should also be openly communicated to the general public both in traditional and social media. All collaborators, funders, and assistants need to be acknowledged; conflicts of interest need to be declared. Negative results (meaning e.g. that the intervention studied did not work) are as valid as positive ones.

Reviewing, evaluating and editing: Researchers take seriously their commitment in refereeing, reviewing, and evaluating research manuscripts, funding or job applications, promotions, and rewards; they carry out these tasks transparently and justifiably, declaring a conflict of interest when relevant.

Violations of research integrity

Failing research integrity and good practices means renouncing one's professional responsibilities; it damages the research process, degrades relationships between researchers, undermines the trust and credibility of research among people and society, wastes resources, and may also bring danger or even harm to research participants, users, the society, or the environment.

Research misconduct and unacceptable practices

Misconduct can happen in writing a research plan, doing research, reviewing it, or reporting it. Fabrication means making up results and presenting them as real. Falsification is manipulating research material, equipment, or the process, or changing, leaving out data or results without justification. Plagiarism happens when someone uses other people's work and ideas without giving proper credit (=referencing) to the original sources, thus violating the IPR of the original authors.

[2] Reporting guidelines: example: Enhancing Quality and Transparency of Health Research https://www.equator-network.org/about-us/what-is-a-reporting-guideline/

[3] General Data Protection Regulation (GDPR) https://gdpr-info.eu/

Dealing with violations and allegations of misconduct

Violations need to be dealt with transparently and consistently, considering integrity and fairness. Integrity means that investigations of suspected misconduct are fair, confidential, comprehensive and quick. Investigations should be accurate, objective and thorough. Conflicts of interest need to be declared; conclusions should be reached; and whistle blowers need to be protected. Further, the procedures for dealing with violations need to be publicly available and accessible to ensure their transparency and uniformity.

Fairness means that the process is fair to all parties; those accused of misconduct are given full details of the allegations and allowed a fair process for responding to allegations and presenting evidence. Action to those shown to have participated in misconduct has to be proportionate to the severity of the violation. Appropriate restorative action is taken when researchers are freed from suspected misconduct. It needs to be remembered that anyone accused of research misconduct is presumed innocent until proven otherwise.

Dealing with misconduct and unacceptable practices. The researchers' perspective

Nicole Föger

It might happen that a researcher observes a behaviour that doesn't seem to be in line with good research practice. This might happen in the same institute or in a project with partners from other institutions and/or even other countries.

Usually this is the first time the researcher has to look for existing guidelines on research integrity and the processes for dealing with research misconduct at their own institution. How do they know if research misconduct or unacceptable practices occurred? Is there a national code

of conduct or are there any specific research integrity guidelines at the researcher's institute? If so, do these guidelines state that the observed misbehaviour falls under the definition of research misconduct or unacceptable research practices? Do they also state where one has to go and report it?

In a collaboration with project partners from other institutions or even other countries, it is highly recommendable to establish written agreements for how to deal with joint results and findings, but also what to do when there is a breach against the rules of good scientific practice: which guidelines on research integrity to follow (e.g. the European Code of Conduct) and who is responsible for dealing with cases of research misconduct. In large consortia the establishment of an ombudsperson or confidential person for conflicts could be considered as well.

If there is an ombudsperson or other designated official at their institution, the researcher can talk to them confidentially to seek preliminary advice and discuss what to do and how to deal with the situation. The ombudsperson is usually not the person that investigates allegations. On the other hand, in research funding organisations research integrity issues are often dealt with in the legal department.

If a researcher needs to make a formal allegation at the committee that handles cases of research misconduct, then a written statement is often needed. Usually information about the precise processes and procedures are part of the corresponding website. For instance, are anonymous complaints accepted? What are the complainant's further responsibilities and duties? Is there any protection from possible retaliation

What can a researcher do?

- ► Take a course about good research practice and let all your staff members attend such courses.

- ► Have regular working meetings discussing results and challenges in an open culture; let staff members talk about errors and mistakes. Offer support and advice and do not spread fear amongst them.

- ► Always check raw data before publishing manuscripts and submitting projects proposals.

offered? Will the accused know the name of the complainant? What about confidentiality during and after the investigation?

By all means, make use of all support you can get, but be careful about confidentiality and do not try to solve this difficult situation alone!

Finally, senior researchers as leaders have a special responsibility in creating and fostering an open culture of research integrity. Not only are they role models, but they also have responsibilities to train early career researchers in all matters of good scientific practice. Senior researchers should facilitate open discussion about challenges in daily research work and the opportunity to speak freely about mistakes and failures someone faced.

Promoting research integrity. Best practices for individual researchers

Dick Bourgeois-Doyle

Though statements on the promotion of research integrity often focus on the administrative and policy structures, most acknowledge that success ultimately rests on the attitudes and day-to-day actions of individual researchers[1]. UNESCO's statement on appropriate scientific practice (The UNESCO Recommendation on Science and Scientific Researchers)[2] was, for example, revised and renamed in 2017 to stress equally the obligations and rights of the individuals who pursue science as well as national systems and the larger scientific enterprise.

[1] The Mutual Learning Exercise on Research Integrity (2019) https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-research-integrity

[2] The UNESCO Recommendation on Science and Scientific Researchers (2017) https://en.unesco.org/themes/ethics-science-and-technology/recommendation_science

Researchers at all levels thus have a recognised responsibility to contribute to building a research workplace that is healthy, open, and honest.

Senior researchers provide guidance, direct others, and set an example that frames a laboratory's tone and attitudes. Junior researchers should not use inexperience as an excuse for lapses; they have a special responsibility to learn institutional expectations and accepted standards.

Sampling of best practices for individual researchers

▶ **Understanding and modelling institutional expectations**

Individual researchers have a duty to be familiar with their institution and research system's research integrity expectations, to follow these requirements in their own work, and to reference policies and processes whenever appropriate when collaborating with others. This obligation means more than merely taking institutional training as required; it also urges individuals to seek out other opportunities to learn through literature and voluntary workshops and to access resources online[3]. Researchers should also recognise that integrity in research extends beyond prescribed ethical standards and also requires knowledge of and adherence to rigorous methods in the maintenance of research records and data analysis. In conjunction with reference to such prescribed expectations, all research activities should be imbued with a general attitude of openness and honesty.

▶ **Creating an environment for dialogue and communication**

Open dialogue and supportive work environments are critical ingredients to any effort to foster integrity in research, and these are areas in which all researchers

have a role to play. Again, this effort can be founded upon awareness of processes and expectations. Though these administrative requirements and policy provisions can seem abstract in isolation, they offer useful tools for discussing and resolving difficult issues in the laboratory. If, for example, an institution or programme has set out clearly defined requirements around authorship and attribution, the rules can defuse difficult discussions and make the process of publication more efficient. A source of expertise in research integrity issues and processes can be a useful resource within a research group and the basis for constructive mentoring. Researchers should thus consider maintaining awareness of relevant trends and issues within their disciplines.

▶ **Supporting investigation of research misconduct**

Research integrity policies are by necessity coupled with provisions for the formal investigation of allegations of research misconduct and other breaches of these policies. This process typically calls for creating investigation committees and mechanisms for appeals and involving peers in processes that strive to respect the

rights of all parties. Individual researchers, not involved directly in cases, may therefore be called upon to contribute expertise and possibly serve on investigation and review committees; they should do so, recognising the critical importance of expert involvement in a fair and competent resolution of these issues. All research staff also have a responsibility to address and communicate likely breaches of research integrity to authorities as appropriate and to cooperate with relevant journal and government inquiries as well as institutional procedures.

▶ **Continuous improvement**

Because incidents of research misconduct and even minor breaches of policy can affect the reputation of institutions as well as the individuals involved, a strong impulse to minimise communication and discussion of incidents (both during investigations and in the aftermath) can be expected in many organisations. However, a best practice, founded upon the desire to learn and improve, is to review lessons learned with all stakeholders and, in fact, to formally communicate the findings of investigations to key parties, such as journals that may need to retract or correct publications. Other individual researchers (not only co-authors and laboratory collaborators) may be

affected by these measures and thus have an active interest in any efforts to rehabilitate reputations. In fact, researchers should seek opportunities to discuss experiences with peers and learn while respecting privacy and legal considerations. Should a researcher's institutional policies and processes lack clarity, researchers should raise their concerns with appropriate authorities and volunteer for policy working groups or other exercises aimed at improvement. Equally, researchers should not only participate actively in training programmes, but provide feedback on the format and content to benefit other colleagues and to help foster a research integrity culture in their organisations.

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[3] U.S. Office of Research Integrity – The Lab – training tutorials https://ori.hhs.gov/thelab

The distrust of science and research: how to communicate the thorny issues

Raül Toran

Without science there is no progress[1]. Countries do not research because they are rich; they are rich because they have invested money to do research[2]. Advances in science and technology make us advance and allow social, cultural, economic and health improvements of the population. Research, development and innovation (R&D+I) allow improvements in production processes and citizens' life. Advances in science have allowed us to live longer. Globally, life expectancy has increased in just two centuries from less than 30 years to over 70

[1] Sin ciencia no ha progreso. Juan Ignacio Pérez https://culturacientifica.com/2012/05/02/sin-ciencia-no-hay-progreso/

[2] Los países no investigan porque son ricos, son ricos porque investigan. Bernardo Herradón. Madri+D. 02/01/2012. https://www.madrimasd.org/blogs/quimicaysociedad/2012/01/02/133011

years (80 in the case of Japan, Italy and Spain), and according to some trends, it will reach 100 years by the end of this century[3]. All this is thanks to social and medical (scientific) advances. Despite the advantages of R&D+I, there are certain fields that do not inspire confidence among the population[4], such as neuroscience, artificial intelligence, robotics, and genetic engineering. On the one hand, because they are far from citizens and on the other, because of the impacts and risks that they can have on health, employment or society itself.

According to Eurobarometer results from April 2019, almost half of the European public (48%) believes that vaccines can produce serious side effects, 38% think they can cause the diseases against which they protect, and 31% are convinced that they can weaken the immune system. These figures are also the result of an increased spread of disinformation about the benefits and risks of

vaccines through digital and social media[5]. All this shows distrust in traditional medicine and reflects the great confusion between science and pseudoscience. Regarding the degree of confidence in childhood vaccines, 79% of people agree that vaccines are safe, and 84% agree that they are effective, according to the Welcome Global Monitor on how people around the world think about science and major health challenges[6].

How to deal with the perception of the risks of research

Science and research can bring advantages for society but also certain risks. For example, the development of artificial intelligence (AI) may give rise to the development of autonomous weapons or the manipulation of society

through fake news. This happened with the case of Brexit, where AI was used together with personal data and algorithms to manipulate information in order to change voters' intentions in a referendum. AI, like other technologies, can be a risk if we misuse it, but these technologies provide a great opportunity for economic and social development if we know how to make good use of them[7]. A fake article that related the triple viral vaccine with autism generated significant mistrust in vaccines. But several studies, the most recent of which was published in March 2019, studying more than 600,000 children in Denmark, have proved that this relationship is false[8]. Vaccines are safe and have prevented many deaths. The current

distrust in vaccines has led to an increase in measles cases in Europe.

It is possible to deal with the perception of the risks of science through good communication of science and engagement with the public.

Citizens finance most science and research works through national budgets or grants, therefore their findings – whatever they might be – have to be communicated to the public in an objective and understandable way so that they are able to extract conclusions and judge the impact in their lives. Having an informed citizenship contributes to gaining more trust and avoiding misinterpretations[9].

[3] Viviremos 100 años, pero ¿cómo? Cristina Galindo. El País. 12/08/2018. https://elpais.com/elpais/2018/08/10/ciencia/1533911822_785860.html

[4] Los beneficios y riesgos de la ciencia, tecnología e innovación. Clara Inés Pardo Martínez. Portafolio. https://www.portafolio.co/los-beneficios-y-riesgos-de-la-ciencia-tecnologia-e-innovacion-516414

[5] https://www.who.int/news-room/detail/12-09-2019-vaccination-european-commission-and-world-health-organization-join-forces-to-promote-the-benefits-of-vaccines

[6] https://wellcome.org/what-we-do/our-work/public-views-science-and-health

[7] Is Artificial Intelligence Dangerous? 6 AI Risks Everyone Should Know About? Forbes. Bernard Marr. 19/11/2018. https://www.forbes.com/sites/bernardmarr/2018/11/19/is-artificial-intelligence-dangerous-6-ai-risks-everyone-should-know-about/#5a69fb752404

[8] https://elpais.com/elpais/2019/03/05/mamas_papas/1551783023_370147.html

[9] Young Scientists Code of Ethics. World Economic Forum. January 2018. https://widgets.weforum.org/coe/

Tips for good communication

If you want to communicate well about controversial issues, keep in mind these tips[10]:

▸ Make sure your main message is clear.

▸ Be objective about the topic.

▸ Be fully aware of all sides of the issue.

▸ Keep it cool and conflict-free.

▸ Be comfortable with your position and with yourself.

▸ Establish yourself as an expert source.

▸ Be careful when communicating risks or benefits identified in your research in order not to create false expectations.

▸ Do not use personal attacks: they may cause the public to question your motives and objectivity.

▸ Provide science education and engage with the public, participating in events like science fairs, parliamentary scientific committees, and science and research dissemination programmes with schools.

▸ If possible, contact your press or media officer in your institution to get help in the research process for disseminating the results.

It is very important to remember that communication and engagement with the public is a great opportunity to make your research visible and to communicate directly with citizen groups to discuss the implications of your work. Explaining what is currently known reinforces the transparency of research and fosters trust[11].

[10] Martha Filipic (Ohio State University). Tips for Communicating Controversial Issues - https://communications.cfaes. ohio-state.edu/resources/marketing-and-brand-strategy/tips-communicating-controversial-issues

[11] http://www.sirc.org/messenger/

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Subject to change

Path :2: Integrity

Creating and Safeguarding Excellent Research Practice

Research Integrity at a glance

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Content

Introduction

Julia Prieß-Buchheit

In the last decades, many research organisations have encountered severe cases of research misconduct. The cases reveal that researchers committed fraud by plagiarising texts, data and graphics; falsifying research materials; fabricating research results; and tampering with equipment. This has damaged the trustworthiness of research results and in some cases has even led to malpractice in drug prescription, mobile apps, nutrition tips etc. Research misconduct cases occur across disciplines, from physics, psychology, medicine and informatics, to pedagogy, law and others. These cases undermine reliability, honesty, respect, and accountability in research.

Under the umbrella of **Research Integrity**, the research community is combining forces to tackle these challenges. Strategies under this umbrella offer guidance for researchers, organisations that perform and fund it, editors, publishers, and others.

These strategies are both highly valuable and worth implementing, because without research integrity, trust in research inevitably fades, leaving society and researchers "vulnerable to misinformation, suspicion and poorly formulated choices"[1]. "Failing to follow good research practices violates professional responsibilities. It damages the research processes, degrades relationships among researchers, undermines trust in and the credibility of research, wastes resources and may expose research subjects, users, society or the environment to unnecessary harm"[2].

In order to benefit from the products of research, such as smart homes, penicillin, de-escalation strategies, space travel etc., society relies on honest researchers. Especially now, as the research landscape faces ethical challenges such as artificial intelligence and big data, research and educational administrations cannot emphasise the virtue of research integrity enough.

[1] Science Europe Working Group on Research Integrity (2015): Seven Reasons to Care about Integrity in Research. Online resource: http://www.scienceeurope.org/wp-content/uploads/2015/06/20150617_Seven-Reasons_web2_Final.pdf. (25.10.2019)

[2] ALLEA - All European Academies (2017) The European Code of Conduct for Research Integrity, Revised Edition, Berlin, p.8.

Research integrity is a significant benchmark in the pursuit of knowledge, "obtained through systematic study and thinking, observation and experimentation"[3]. It should be fostered in research procedures and research environments, as well as in education towards research professionalism.

Administrations play a crucial role in fostering research integrity. By emphasising research integrity, they can actively set the highest possible standards while supporting excellence in their organisations. In the following pages, as part of Path2Integrity (www.path2integrity.eu), authors outline how Research Integrity can be supported within various organisations. What is Path2Integrity? – Path2Integrity is a European project, funded by the European Commission, that raises awareness about research integrity and educates on how to argue in favour of responsible research and reliable research results. Path2Integrity offers organisations two approaches supporting research integrity. Using Path2Integrity's learning cards, organisations can learn more about research integrity. Meanwhile, Path2Integrity's campaign materials can help organisations raise awareness.

Why is Research Integrity important for your organisation?

As pointed out by the Science Europe Working Group, there are seven reasons why you should emphasise research integrity[4]:

1. Research Integrity Safeguards the Foundations of Science and Scholarship

2. Research Integrity Maintains Public Confidence in Researchers and Research Evidence

3. Research Integrity Underpins Continued Public Investment in Research

4. Research Integrity Protects the Reputation and Careers of Researchers

5. Research Integrity Prevents Adverse Impacts on Patients and the Public

6. Research Integrity Promotes Economic Advancement

7. Research Integrity Prevents Avoidable Waste of Resources.

[3] ALLEA - All European Academies (2017) The European Code of Conduct for Research Integrity, Revised Edition, Berlin, p.3.

[4] Science Europe Working Group on Research Integrity (2015): Seven Reasons to Care about Integrity in Research. Online resource: http://www.scienceeurope.org/wp-content/uploads/2015/06/20150617_Seven-Reasons_web2_Final.pdf. (01.03.2018)

What is your role in research integrity?

Whether research is conducted in a reliable manner is in the hands of researchers; however, it is also influenced by their environment. Research is embedded in large research systems, as researchers work and collaborate with scientific journals, governmental and regulatory agencies, funding agencies, and many others. All these actors play important roles in ensuring that research is conducted responsibly.

The environment in which researchers work is highly influenced by organisational structures as well as by research administrations and can vary greatly. Some researchers conduct their research at their desk at home. Others are part of more complex institutions. One extraordinary research environment, for example, is the CERN institute in Switzerland. To conduct experiments in high energy physics, the CERN built a particle accelerator, the so-called large hadron collider. At 27 kilometres, the large hadron collider represents a very unique research environment, with special requirements for honesty, accountability, transparency and reliability in collaborative work. A completely different environment is the world's largest library for economic literature. The ZBW – the Leibniz Information Centre for Economics in Kiel, Germany, provides economists and related researchers with access to important information and data within their field following the FAIR principles (findable, accessible, interoperable and reusable data). The organisation fosters FAIR principles with the Go FAIR initiative, which acts through (cultural) change, training (data stewardship) and building (data infrastructure).

Both examples demonstrate that research environments greatly influence what researchers do, as well as how responsibly they do it. The examples also point to the possibility of inducing change by altering environmental factors, for instance by wisely managing incentives, increasing transparency of misconduct cases, making the applicable standards for research integrity explicit, etc.[5] On top of these environmental factors of change, research organisations can implement educational programmes to foster research integrity.

[5] See the Bonn PRINTEGER Statement: Forsberg, E.-M. et al. (2018). Working with Research Integrity—Guidance for Research Performing Organisations: The Bonn PRINTEGER Statement. Science and Engineering Ethics. doi:10.1007/s11948-018-0034-4

What is research integrity and why is it important?

Arja R Aro, based on ALLEA: The European Code of Conduct for Research Integrity, revised edition.

What is research?

Research is the systematic and transparent approach to gain knowledge. Knowledge is needed to understand our world, develop technology such as robots, treatments for diseases, or ways to protect the environment. Thus, research is very important to society. Research needs to be trustworthy and carried out transparently. Research knowledge is not only about technology and science; it also needs to consider individual, community, and cultural values. New technology based on research (e.g. self-driving cars) needs to be carefully evaluated to decide if, where and how it could be used to serve humankind instead of causing additional harm.

Different stakeholders of research

Researchers are not the only actors in research. Those who fund research (private industry or societal actors, organisations) have power over the research topic chosen and can influence it. Research can be done in humans, animals, or the environment; integrity means that they all need to be treated with respect and harm should be avoided. Further, researchers need to act inclusively and respect each other.

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[1] The European Code of Conduct for Research Integrity https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

Most societies have built structures such as research integrity or research ethics committees to safeguard research. While most medical and clinical research is well covered by ethics committees and regulations, as is social and behavioural sciences research using surveys or interviews, technical science and the use of its products (e.g. drones) is seldom covered by these committees. There is an urgent need to establish regulations, institutional review boards and research integrity committees to also guide this kind of research. In addition to the evaluation of research plans, a proper monitoring system should be built to monitor and safeguard the research process and the impact of research in society.

Principles of research integrity

The central principles of research integrity are reliability, honesty, respect, and accountability[1]. Reliability means that the research is done well, with a proper research design, relevant methods, good data analysis, and rational use of resources. Honesty means that research is planned and done, evaluated and communicated transparently, fairly, and without biases. Respect covers colleagues, research participants, the society, ecosystem, culture and environment. Accountability (=responsibility) covers the research process

from conception to publication, management and organisation, training, supervision and mentoring juniors, and managing the wider impact of research.

Good research practices

The research environment should value integrity and deal with violations to good research practice. When research material and management are well organised, research can be reproduced. Training, supervision, and mentoring should aim at good and rigorous research process and methods, relevant integrity and ethics regulations and codes, and it should involve researchers, leaders, supervisors and mentors.

Research procedures need to be based on what is known about the topic already. Careful research process uses resources reasonably, publishes results with correct interpretations, respects the confidentiality of the information, and adheres to the relevant reporting guidelines[2].

Safeguards cover relevant regulations and codes and deals with research subjects (human, animal, cultural, biological, environmental, physical) with respect and care; considers the health, safety and welfare of the community and collaborators; and is sensitive to age, gender, culture, religion, ethnic origin, and social class.

Data practices and management need to ensure transparency and access to data 'as open as possible, as closed as necessary' and be FAIR (Findable, Accessible, Interoperable, Re-usable) as well as to respect the intellectual property rights (IPR) of research outputs. In Europe, new regulations have been produced for data protection[3].

Collaborative working means that all partners take responsibility for research integrity, agreeing on the goals and the need for open communication; on following codes, laws and regulations; and on handling conflicts. All partners are informed and consulted about submitting the research report for publication.

Publication and dissemination: All authors are fully responsible for the content of research publications (unless otherwise stated). Author order is agreed together; authorship needs to based on significant contributions to the design, data collection, analysis, and interpretation of results. Generally, results should also be openly communicated to the general public both in traditional and social media. All collaborators, funders, and assistants need to be acknowledged; conflicts of interest need to be declared. Negative results (meaning e.g. that the intervention studied did not work) are as valid as positive ones.

Reviewing, evaluating and editing: Researchers take seriously their commitment in refereeing, reviewing, and evaluating research manuscripts, funding or job applications, promotions, and rewards; they carry out these tasks transparently and justifiably, declaring a conflict of interest when relevant.

Violations of research integrity

Failing research integrity and good practices means renouncing one's professional responsibilities; it damages the research process, degrades relationships between researchers, undermines the trust and credibility of research among people and society, wastes resources, and may also bring danger or even harm to research participants, users, the society, or the environment.

Research misconduct and unacceptable practices

Misconduct can happen in writing a research plan, doing research, reviewing it, or reporting it. Fabrication means making up results and presenting them as real. Falsification is manipulating research material, equipment, or the process, or changing, leaving out data or results without justification. Plagiarism happens when someone uses other people's work and ideas without giving proper credit (=referencing) to the original sources, thus violating the IPR of the original authors.

[2] Reporting guidelines: example: Enhancing Quality and Transparency of Health Research https://www.equator-network.org/about-us/what-is-a-reporting-guideline/

[3] General Data Protection Regulation (GDPR) https://gdpr-info.eu/

Dealing with violations and allegations of misconduct

Violations need to be dealt with transparently and consistently, considering integrity and fairness. Integrity means that investigations of suspected misconduct are fair, confidential, comprehensive and quick. Investigations should be accurate, objective and thorough. Conflicts of interest need to be declared; conclusions should be reached; and whistle blowers need to be protected. Further, the procedures for dealing with violations need to be publicly available and accessible to ensure their transparency and uniformity.

Fairness means that the process is fair to all parties; those accused of misconduct are given full details of the allegations and allowed a fair process for responding to allegations and presenting evidence. Action to those shown to have participated in misconduct has to be proportionate to the severity of the violation. Appropriate restorative action is taken when researchers are freed from suspected misconduct. It needs to be remembered that anyone accused of research misconduct is presumed innocent until proven otherwise.

Dealing with misconduct and unacceptable practices. The organisations' perspective

Nicole Föger, based on the ENRIO Handbook, Recommendations for the Investigation of Research Misconduct

Every institution should have and/or follow a code of conduct and have clear policies regarding how to handle cases of research misconduct and unacceptable research practices. The code of conduct could be the European Code of Conduct, a national guideline (or law), or – in their absence – local rules. The document should describe and define research misconduct as well as unacceptable research practices. However, it is crucial that those guidelines are actively communicated, accessible (e.g. on the institution's website), and regularly evaluated and revised. In many institutions, adherence to these guidelines are part of employment agreements or funding contracts.

Cases of research misconduct can occur at any institution, so it is important is to deal with them properly. There must be clearly written procedures, consistent with national law or regulations, and these should be easily accessible and publicly available. The committee (or similar body) for dealing with research misconduct should have a clear mandate and must be endorsed by the management. It needs clear and transparent rules stating how members are elected, their roles and responsibilities, the length of their term, and their established autonomy and independence. No influence or interference (e.g. political, personal,..) from outside should be allowed to affect the process or outcome of the investigation. Moreover, the institution should do their utmost to protect and support members of such committees or other involved experts from any retaliation or mistreatment.

All individuals involved in investigations need to be objective and unbiased in their review of allegations. Any real or perceived conflict of interest needs to be immediately disclosed and avoided or managed. The disclosure of any conflict of interest among committee members, internal and external experts and others involved in handling allegations must be dealt with and documented in a transparent way.

It is better to have standing committees as opposed to ad hoc committees because it is important to have an experienced group of members and to build up collective knowledge of how to deal with cases. This helps in the long run to guarantee consistency of decision-making.

Often researchers wish to obtain advice on a confidential basis before making a formal allegation at the committee handling cases on

research misconduct. Early career researchers especially are looking for a low-threshold alternative. For this purpose, it is advisable to have an ombudsperson or other designated confidant at the institute.

The possible consequences of raising a concern or making a formal allegation in good faith, and the process for doing so, need to be explained on a publicly available and easily accessible platform, for example on the website. Potential reactions to malicious or bad faith complaints should be mentioned and consequences described, as these acts could also be defined as research misconduct or unacceptable research practice.

Procedures should clearly indicate to whom allegations should be submitted and from whom allegations will be accepted and in what form (oral, written and/or electronic). Are anonymous allegations accepted? What are the further responsibilities and duties of the complainant and does this person need to be protected from potential retaliation?

Procedures and processes regarding possible research misconduct or unacceptable research practices must be fair, detailed, thorough, comprehensive and objective. It is recommended to have clear deadlines for each procedural step; however, balance should be maintained between thoroughness and speed. The investigation also needs to be conducted as confidentially as possible to protect those who raised the allegations as well as the accused and witnesses.

Putative sanctions should be set out and made known as part of the policy, and it should be clarified whether an appeal from a process and

sanctions is available and to whom. The policy regarding dissemination and communication during and after an investigation should also be considered.

The most important question is whether there are systemic problems at the institution. Reasons for research misconduct, its context, and repeated violations of good practices should be evaluated thoroughly. Lessons learnt need to be incorporated into institutional research integrity promoting plans to improve research culture.

It is highly recommended to establish agreements in cross-institutional and cross-border collaborative projects in the very beginning, for instance as part of a consortium agreement. The Montreal Statement and the OECD "Boilerplate for International Collaborative Research Projects" can be used as a basis.

Finally, in line with transparency (e.g. anonymised summaries of investigated cases), sanctions as well as challenges and improvements discussed at the institutional level should be made public on an annual basis to enable institutions to learn from each other.

What institutions can do:

(based on Science Europe working group on research integrity, Recommendations and PRINTEGER Statement)

- ► Easy accessible and clear guidelines and policies about research integrity

- ► Accessible contact data of responsible persons/committees

- ► Make research integrity guidelines part of the employment agreements and funding contracts

- ► Collaboration agreements

- ► Offer research integrity-training and mentoring throughout professionals' entire career

- ► Clear assignments in the supervision process

- ► Wise incentive management

- ► Facilitation of open dialogues, improvement of work environment, and work satisfaction

Safeguarding the reputation of universities, funding agencies and other research organisations. To do and not to do

Dirk Lanzerath

For more than 50 years, there has been a real boom in ethical debates in research. But is ethics in research an achievement and an enrichment or simply something that's 'nice to have'? Is it a necessity or a luxury? Does the reputation of universities, funding agencies, and scientific journals even depend on the fulfilment of ethical requirements?

There are numerous reasons why debates on research integrity and research ethics have become commonplace. There are more and more technological achievements that dramatically change human life and social practice (e.g. life sciences, computers) and overcome and shift natural or technical boundaries (e.g. genetic engineering). This raises the question of whether new ethical or legal boundaries are needed to replace the old ones, especially if what has been achieved has negative side effects (e.g. climate change, loss of biodiversity, health risks). In addition, globalised, organised research leads to conflicts over the standards of values and norms when different cultural areas meet in the lab or in the lecture room. In a globally active research environment, this happens all the time and leads to the request for a cross cultural assessment of values.

If research and science are to be understood, not as areas separated from society, but as integral parts of society and as a social practice, then research and science must be measured not only by the methods of its disciplines, but also by compliance with standards of research ethics and research integrity. Individual actors are not the only ones answerable to these; responsibility lies with the entire research infrastructure, from research institutions to funding organisations and the scientific journals that publish the results.

In many cases, it has become common practice for researchers not only to comply with ethical standards when carrying out research, but also to prepare an ethics report for a funding application or to obtain a positive opinion of an ethics committee beforehand. This practice generates mixed results:

On the one hand:

▶ Ethics can improve science, which can be more thoughtful if ethical reflection is included from the outset.

▶ Ethical considerations can better link research to social needs by stressing that science and research are not the opposite of society, but an integral part of it.

▶ It leads scientists to look at their research practice from a different perspective.

But on the other hand:

▶ More time for ethical reflection can also cause frustration because more work needs to be prepared.

▶ The research preparations involve much more paperwork and bureaucracy.

▶ Some scientists clearly state that they are very much in favour of concentrating on a checklist that needs to be filled out rather than articulating the ethical issues themselves.

Therefore, there is always the danger that ethics will degenerate into pragmatic lip service and be perceived as an annoying duty. To avoid this, the infrastructure in which research takes place needs to consider ethics clearly as a quality feature of research that not only incorporates the rules of scientific ethics but also acknowledges its social obligations. That leads to responsible research and science.

In order to guarantee the latter, more and more ethics and research integrity classes are being introduced in courses of study outside medicine, for example in other life sciences, in technology, engineering, economics, and the social sciences. At least the young scientists should be trained in ethical thinking at an early stage. This is in line with the ethos of science that Robert Merton explains in his classical readings. According to his reflections on the core elements of the norms of science and research, the substantial findings of science are a product of social cooperation and belong to the community. They are a common heritage in which the individual producer's own resources are severely restricted. They are not the sole property of the discoverer and his or her heirs. Moreover, scientists should act for the benefit of a joint scientific undertaking and not for personal gain; they should be disinterested in objectives other than scientific purposes. This is true independence. In the truest sense of the concept, science is a common, intergenerational event. Civilisation depends on good practice in science. But in reality, what's often heard is: these are my projects, my data, my laboratory, my promotion, my career, my doctoral student … this practice is far from Merton's criteria. However, when universities do not fulfil their responsibilities, the researchers may forget what they have learned theoretically and from case studies, falling into the trap of hierarchy, competition, and promotional advancement when they start their careers.

Whatever is taught in the ethics programme will not bear practical fruit unless science and research are embedded in an appropriate infrastructure that takes research ethics concerns seriously. The infrastructure should not act against careers and competition, but these

must be embedded in an ethical environment that is not regulated by ethics checklists, but through correct customs and habits. Ethical habits can only be learned and implemented if there are good practices and learning models in a functioning environment.

Universities, funding organisations and scientific journals bear great responsibility with regard to this field. Together with research ethics committees and research integrity offices, they form the infrastructure for research integrity and research ethics (www.eneri.eu). Without this infrastructure, a single scientist will be lost. This triad of research institutions, funding organisations and publishers can only guarantee that ethics is not green washing for research by working together and improving the culture of ethics throughout the whole system. These actors should avoid turning ethics into a mere formal act, supporting it as a self-evident habit of the entire system. This can be done by supporting ethical education, compliance and reporting mechanisms for cases of misconduct, guarding against negative career impacts on the reporting researcher. This is the only practice that promotes the reputation of scientists and scientific institutions and which cannot be replaced by a stamp that says 'ethically clean'.

Promoting research integrity. Best practices for institutions and systems

Dick Bourgeois-Doyle

The importance of research integrity to a system's reputation raises the question of how individual universities and other research institutions should promote and nurture it within their walls and what research funding agencies might require of those institutions and their staff.

Recognising this, institutional and system best practices have been inventoried in many formal statements such as those issued by the World Conferences on Research Integrity[1], the Scientific Integrity Consortium[2], and the Secretariat on Responsible Conduct of

[1] World Conferences on Research Integrity Guidance documents (Singapore Statement, Montreal Statement, Amsterdam Agenda) https://wcrif.org/guidance

[2] Scientific Integrity Principles and Best Practices: Recommendations from a Scientific Integrity Consortium (organized by the North American Branch of the International Life Sciences Institute (ILSI North America) and the U.S. National Academies of Sciences, Engineering, and Medicine's Government-University-Industry Research Roundtable (GUIRR)) Science and Engineering Ethics April 2019, Volume 25, Issue 2, pp 327–355, Kretser, A., Murphy, D., Bertuzzi, S. et al. Sci Eng Ethics (2019) 25: 327. https://doi.org/10.1007/s11948-019-00094-3

Research (Canada)[3]. In fact, entire books have been devoted to the relevant issues and practices[4]. Responsible policy specialists and administrators would be well served by intimate knowledge all such works.

But a helpful grouping of key concepts was presented in the 2019 Report of the Mutual Learning Exercise (MLE) on Research Integrity conducted by the European Commission's Horizon 2020 Policy Support Facility. Exemplary best practices drawn from this report and other sources are grouped below under the MLE's four categories.

1. Processes and structures

In order to foster an institutional culture that promotes research integrity, publicly accessible policies and processes should be in place to frame the design, conduct, management, review, and communication of all research activities.

▶ **Clarity of expectations**

The expectations set out in policies should be clearly stated to facilitate public, employee, client, collaborator, and stakeholder adherence to requirements

and to engender trust in the institution's scientific activities. These expectations should be grounded in accepted definitions of research integrity and research misconduct that includes a delineation of requirements for authorship, record keeping, and other features of professional science. In this context, it is important for institutions and relevant staff to be highly networked and aware of evolving practice.

▶ **Comprehensive investigation of research misconduct**

Policies should be complemented by comprehensive guidelines for the investigation of allegations of research misconduct and other breaches of the policies. This process should permit proportionate measures to address minor breaches and present a roadmap for thorough investigation and resolution of serious matters. The latter should prescribe requirements for investigation committees, allow for appropriate appeals, and recognise that this can be difficult for all parties. Therefore, procedures should balance the need for confidentiality and natural justice and prescribe methods of rehabilitation for all involved.

2. Incentives

The issue of incentives is considered a multifaceted challenge for many institutions, as best practices embrace not only measures to promote research integrity, but also measures to avoid incentivising negative behaviours as unintended consequences.

▶ **Positive incentives**

Institutions can actively encourage adherence to research integrity policies through formal sanctions and research performance evaluation criteria that penalise behaviours deemed as inconsistent with integrity in research. More widely accepted best practices, however, tend to be positive recognitions of integrity either informally or formally through awards, access to resources, and professional rewards.

▶ **Avoidance of unintended consequences**

Performance evaluations and rewards based on research publication rates can create pressure to produce volume, cut corners, and ignore matters that do not directly contribute to scientific output. Recognising that competition is generally a positive force in science and that the issues are complex, a best practice is to design performance evaluation in a way that considers the integrity perspective as well as volume.

3. Dialogue and communications

Though efforts to promote research integrity are sometimes difficult to assess in terms of impact, most experts recognise communication and dialogue as essential tools.

▶ **Promotion of research integrity**

To this end, institutions need to establish easy avenues to raise sensitive issues as well as to access basic information on policies, processes, and expectations. These measures would include designating a research integrity officer position whose contact information is well known as well as clear channels to raise issues and concerns in a confidential and safe environment. Communication of the importance of research integrity and expectations by an institution's leadership is vital.

▶ **Learning from breaches**

Because incidents of research misconduct and even minor breaches of policy can impact the reputation of institutions and individuals, a strong impulse to minimise communication and discussion of incidents can be expected in many organisations. However, a best practice, founded upon the desire to learn and improve, is to review lessons with all stakeholders and, in fact, to formally communicate the findings of investigations to key parties, such as journals that may need to retract or correct publications. Furthermore, institutions should seek opportunities to share experiences with peer organisations while respecting privacy and legal considerations.

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[3] Tri-Agency Framework for the Responsible Conduct of Research (2016) (Canada) http://www.rcr.ethics.gc.ca/eng/framework-cadre.html

[4] Fostering Integrity in Research, National Academies of Sciences, Engineering, and Medicine; Policy and Global Affairs; Committee on Science, Engineering, Medicine, and Public Policy; Committee on Responsible Science. Washington (DC): National Academies Press (US); 2017 Apr 11.

4. Training and education

As awareness and understanding of policies, processes, and expectations are fundamental to the success of any institutional effort to promote research integrity, training and education programmes are important components of any research integrity strategy.

▶ **Modes of training**

Institutional training programmes can assume varied formats: online, in-person presentations, role-playing, other interactive approaches, and myriad combinations. Furthermore, training can be prescribed as mandatory for specific employee groups or presented as a beneficial and enjoyable learning opportunity for all. A best practice is to consider the experiences of other organisations and all options, but to adapt training programmes to the specific needs and culture of the institution concerned.

▶ **Assessment**

This adaptation may be an iterative process based upon experience in training sessions and their follow-up. It is therefore highly advisable that training and education be subjected to formal assessments: feedback from course participants, testing of knowledge gained and retained, and evaluations of the broader impact on the institutional culture as well as of the behaviour of the recipients of training.

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Path 2 Integrity

5 postcards

Subject to change

10 Steps for Writing an Academic Paper on Text-based Research

1 Getting started: what would you like to research?

Identify an issue, problem, or topic in a particular field of study that appeals to you personally. Then try to express your interests – as an exciting question – or as a bold statement.

2 Find basic background information

Look for credible sources of information: written interviews, letters, films, books, photographs or other artefacts. Use library catalogues and online resources. Take note of any references suggesting that someone else is working on your issues. If there are many others, consider rephrasing your question or statement to narrow your focus or to take a wider view.

3 Define your research approach

Decide more specifically how you want to answer your question.

You can:

- explore the issues in depth;
- analyse, classify, and interpret the data produced by others;
- pick an option and compare it to those advanced by other people, evaluating the pros and cons;
- or merge the findings and arguments from many sources to suggest new options and ways of seeing the issue.

Whatever approach you chose, you must justify it with reasons that are convincing, rational, and understandable.

4 Formal literature review

Think of key words that define your question and look for matching indexes and abstracts using search engines such as Google Scholar, Semantic Scholar and Microsoft Academic. Look for references that can help you with your reasoning and plans for making your argument.

5 Assess and review sources of information

You will find more sources of information than you can possibly review or need, so review what you have found and keep those that

- are unbiased and accurate;
- recognise the status quo and existing evidence;
- are produced by authors and organisations with relevant expertise;
- contain an original statement (i.e. from the original source) or explain something better (i.e. from a secondary source)

Seek more sources of information if needed and assess against the above.

6 Confirm your approach and line of argument

In light of this information, ask yourself whether your question still seems valid and whether it points towards new knowledge. Check if your approach can be justified with reasons that are convincing, rational and understandable. If not, go back to Step 1 or 3.

7 Outline and then write your paper

Create an outline of the academic paper you intend to produce. You can search for models online. Then write your paper.

8 Organise information sources in a discipline-appropriate format

Look up how to cite information in the discipline related to your issue. In every discipline, researchers need to know the accepted techniques for direct and indirect quotes as well as for summaries.

Create an alphabetical list of the sources of all of the important information you used. Organise this in the References section at the end of your paper.

9 Give your paper to a respected friend

Share your paper with a trusted friend who can give honest and constructive feedback. Ask them to check your line of argument, spelling and grammar.

10 Hand in your paper

After you have revised the manuscript, considered your friend's feedback and checked your citations, bibliography and line of argument one last time, hand in your paper to your teacher, lecturer or to the editor of a scientific journal.

Are you safeguarding respect and reliablity?

Be original!

Respect authorship

Always give proper credit to all sources consulted and used during your research work. Acknowledging the work your research builds on is an important part of the research process and not doing it constitutes a malpractice called **plagiarism**, that is, **copying**.

Copy paste
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Quote properly

Quoting consists of inserting somebody else's exact phrase and crediting the source in your research work.

- Use quotation marks "__".
- Mention the original authors and the source by adding their names at the end of the quotation in brackets (__) or by adding a footnote.
- Always reproduce the exact words.
- Shorten the phrase if you wish and substitute the eliminated parts with an ellipsis ...
- Insert clarifying information into the quotation by surrounding it with square brackets [__]

Paraphrase properly

Paraphrasing consists of writing somebody else's ideas in your own words. The original author must be mentioned as well.

- Use your own words
- Preserve the meaning of the original text
- Use synonyms
- Include author and source

Summarise properly

Summarising means presenting the main points, facts or ideas of a text.

- Be brief and concise
- Use your own words
- Do not alter the meaning of the original
- Include the necessary references

Don't abuse quoting and paraphrasing!

For more information:
https://zenodo.org/record/3383833#.X3rO8WgzZPY

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Make yourself trustworthy

Be clever and detect fake news!

"Fake news refers to journalism or information that either deliberately or unintentionally misleads people and distorts reality by spreading false information, hoaxes, propaganda or misrepresentation of facts".*

FAKE NEWS!

Main types:

- Misinformation: when false information is shared, but no harm is meant

- Disinformation: when false information is knowingly shared to cause harm

- Mal-information: when genuine information is shared to cause harm

*https://www.oecd-forum.org/users/291420-julie-mastrine/posts/52249-defining-fake-news-is-harder-than-you-d-think

Fake news spreads at high speed, reaching even more people than true information.

Before believing and sharing information think twice and stay trustworthy!

It can be difficult to distinguish between true and false information, but there are clues for detecting fake news:

Story or information difficult to believe, highly improbable

Headlines don't match the contents

Lack of facts, survey data or official statistics

The source is an unknown expert or an "acquaintance"

Published on unusual website domains

Headlines seeking to provoke shock or anger

Presence of unusual spelling and mistakes

Disturbing or graphic imagery to grab attention

Suspicious dates (old information or events can resurface and lead people to believe they just happened)

A few resources for detecting false information:

FactCheck.org
For discerning the truth behind all kinds of political, scientific and public policy affirmations.

Snopes.com
About internet rumours and urban legends.

wolframalpha.com
"Knowledge engine" with facts and data about nearly any subject.

True be or not true be

FACT

A statement that is true and can be objectively verified, or proven

INDISPUTABLE, VERIFIABLE

"Cats and dogs are mammals"

Where
Research/scientific publications
Encyclopaedias
Official statistics
Official reports

Express it right
Evidence shows…
It is proven that…
It has been verified/confirmed that…

OPINION

A statement that holds an element of belief about a certain matter

DEBATABLE, SUBJECTIVE

"Cats are cuter than dogs"

Where
Newspapers
Magazines
TV, radio
Social media

Express it right
It has been suggested that…
My/Our /His/Her/Their beliefs are…
My/Our/His/Her opinion/idea is that…

Bear in mind that in real examples these categories will be mixed up. It is up to you to know how to distinguish them

SPECULATION

A statement made without having enough information to be certain or without firm evidence. Speculation is a guess or conjecture, based on a piece of information

NON VERIFIABLE AT PRESENT

"Cats will surpass dogs' abilities in the future"

Where
Papers
Magazines
TV, radio
Social media

Express it right
I/We/He/She/They predict(s) that…
I/We/He/She/They suspect/reckon(s) that…
Maybe …

RUMOUR

A story, speculation or a piece of information that may or may not be true, and spreads quickly from person to person

FOUNDED OR UNFOUNDED

"The latest pet medications have serious side effects that are killing thousands of dogs and cats every year"

Where
Social media
Junk TV
Junk magazines

Express it right
It is rumoured that…
It seems that…
Allegedly…

2

The Research Process in 10 Steps

Experimental Sciences

1. Observation
The observation of any phenomenon is the first step when you plan any research. Observe the events and phenomena occurring around you.

2. Research question or initial hypothesis
Once you have observed a phenomenon you must propose a well-focused research question. To answer it is the aim of the research process.

3. Exploration
Search for any appropriate and relevant background information related to the phenomena you are researching to enhance the understanding of the context.

4. Definition of variables
Identify the variables playing a role in your research. You must define the independent, dependent and controlled ones.

5. Experimentation
Establish an appropriate methodology to address the research question. You must take measurements of different variables and collect data.

6. Analysis
Analyse the qualitative and/or quantitative collected data to support detailed and valid conclusions to the research question. Data could be processed and shown as graph, tables, statistics...

7. Conclusions

Extract your conclusions about your experimentation and the collected data after making the analysis.

8. Evaluation

Evaluate the research question or the initial hypothesis by using your conclusions. You must check whether the conclusions of your results fit the research question or the initial hypothesis. If so, you can move to the following step. If not, you must modify the research question or the hypothesis, and start again on step 2.
When a hypothesis is widely supported it could reach the status of a theory.

9. Improvements, suggestions and extension

Your research has not finished yet. Propose suggestions for the improvement and the extension of your research that can help future research and other researchers.

10. Communication

Your research is not finished until you publish it by writing a paper or scientific report, and disseminating it through scientific journals, a website, social media, etc… To assess its validity, quality and originality it will be first reviewed by specialists in the same research area in a process called "peer review".

Don't forget to mention all the sources and authors consulted to help you with your work.

Why should I care?

Following and respecting each of these steps makes your research work trusted and recognised.

For more information:
https://path2integrity.eu/ri-materials

Credits: Jordi Mazón Bueso, PhD in Physics, teacher and researcher in atmosphere physics, Polytechnical University of Catalonia.

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Do you challenge bad research and its negative impacts?

Dig in the right place!

There are two types of **information sources**. Primary sources include original data (research results or articles, first-hand accounts, diaries, autobiographies, original works, photographies, maps, archive documents etc). Secondary sources interpret primary sources and include journal articles, books, encyclopaedias, biographies, documentaries, etc.

It is important to check the origin and the reliability of information sources. Nowadays you can reach an endless amount of online documentation and resources, but quantity does not equate to quality and you must be very careful when assessing and select it according to the following criteria:

Check the scholarly approach and tone of the paper. Its main purpose should be to inform, not to persuade.

Check the accuracy, completeness and potential bias of the information. Compare the content to other sources.

Check whether the paper has taken the status quo and prior, existing evidence into account. Look at paper's own references and compare them with other sources.

Check the expertise of authors and the publishing organisations. Review the authors' education, experience and standing in the scientific community.

Check whether the paper is up-to-date, specifically if there are more recent findings and/or whether the cited paper states an original argument. If not, the original (older) source is more valuable than secondary ones.

Why should I care?

Striving for quality sources of information makes your research work trusted and recognised.

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11 posters
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In research, be crystal clear

Transparency increases the value, impact and credibility of research
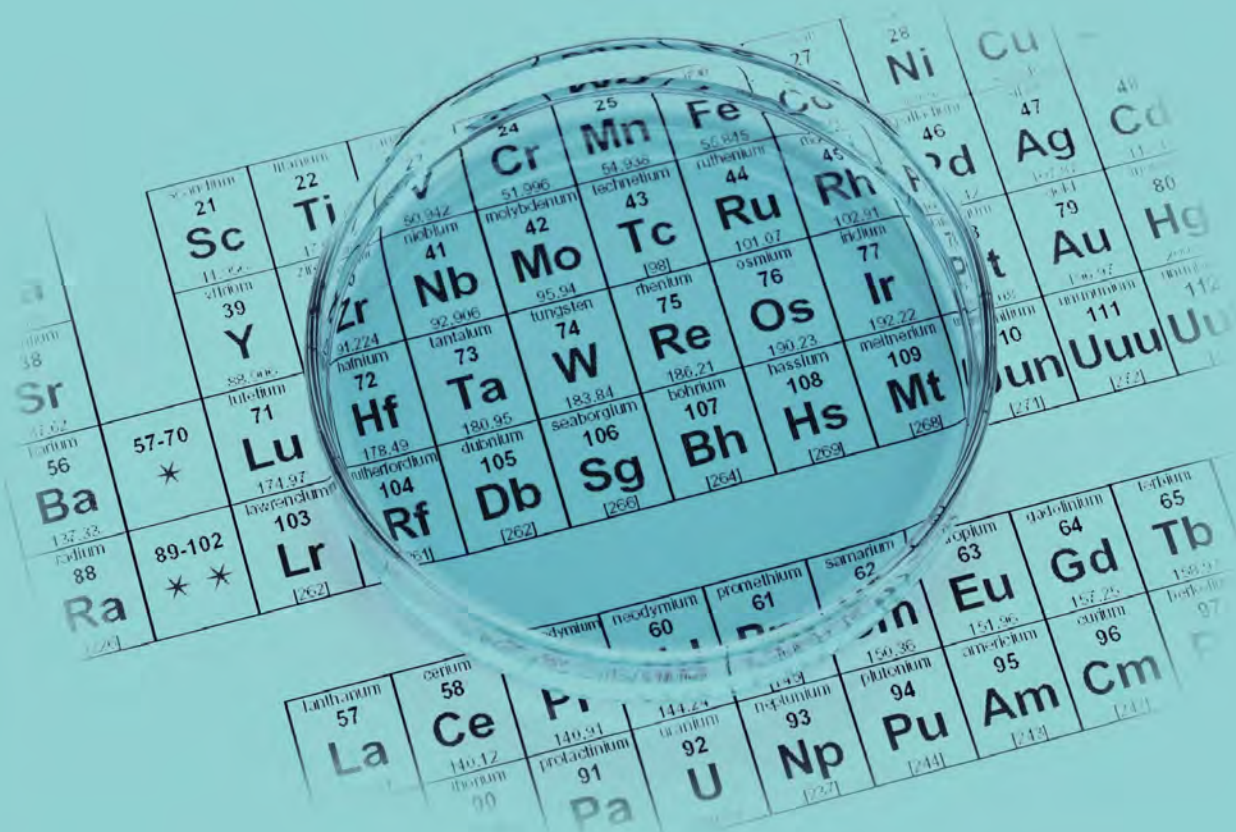
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your *f*acts make
the difference

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In your academic work, verify your sources

Do not become the messenger of misinformation.

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Science and society are built on trust

Be open

Be clear

Be honest

Dorcas Beryl Otieno OGW

Researcher in Higher Education for Green Economy and Sustainability
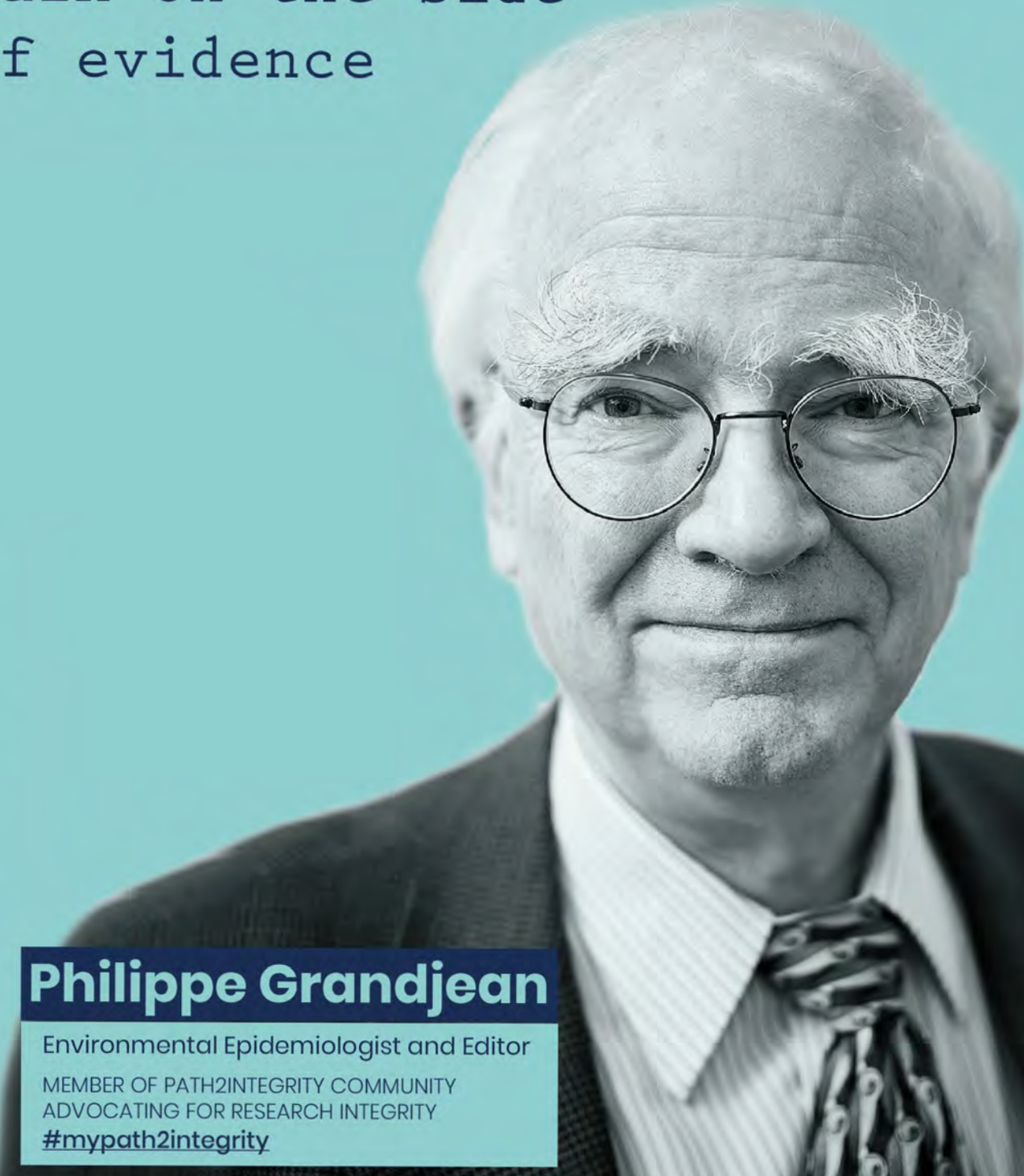
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All your research results are relevant. Don't withhold them

Walk on the side of evidence

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Environmental Epidemiologist and Editor

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Building credibility takes a lot of work

Do you know how to protect your reputation?

Act ethically and responsibly

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Quantum computing researcher

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Photo: Axel Griesch

Research Integrity fosters respect towards all colleagues
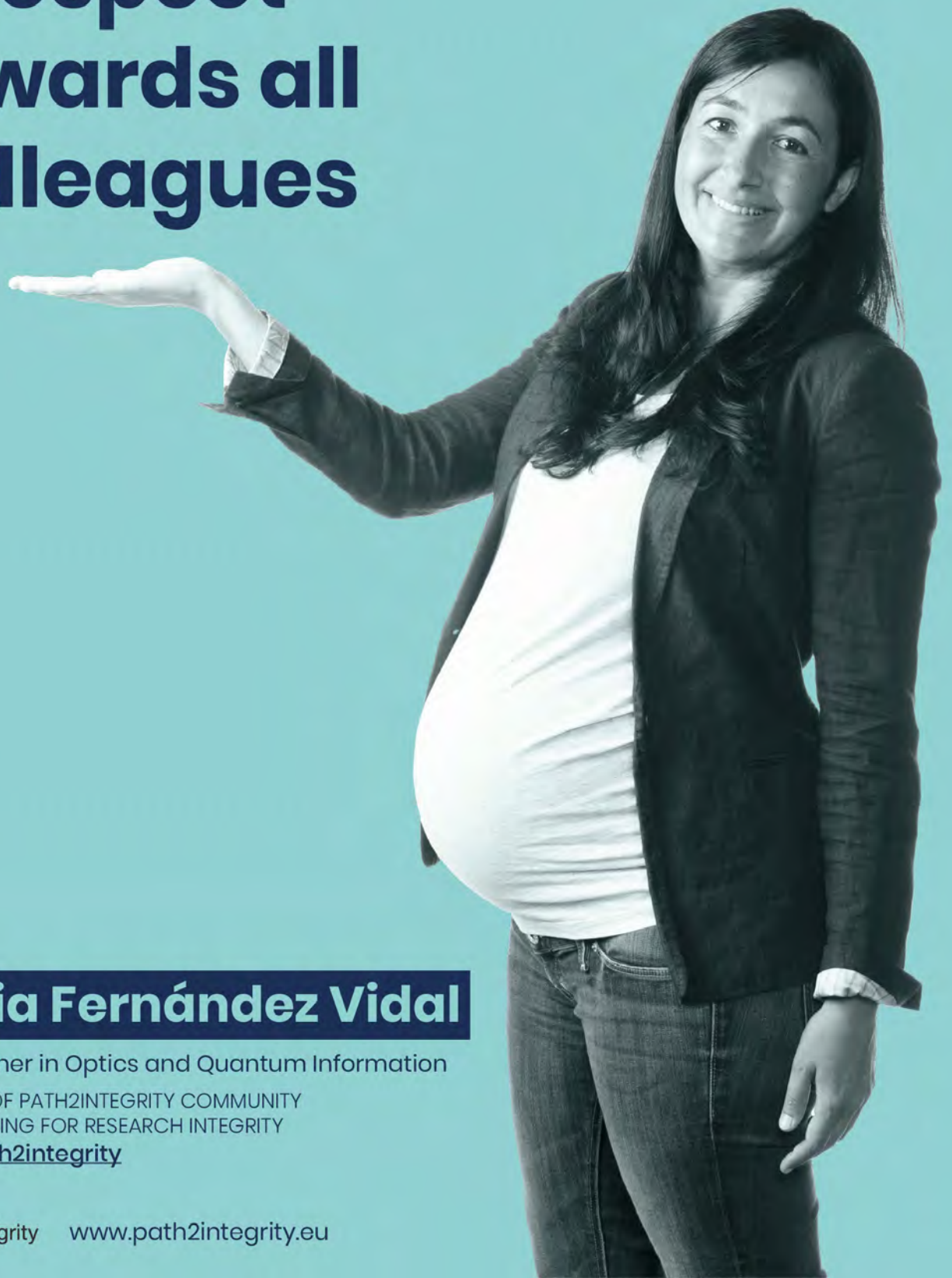
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Published research must be

Good
quality

Accurate

Ethical

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European Code of Conduct for Research Integrity:

Kristina Bliznakova

Researcher in Biomedical Engineering

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National versions of the role-models posters

Subject to change

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Наука и общество се градят на доверие

Бъди открит

Бъди ясен

Бъди честен

Кристина Близнакова

Доцент по биомедицинско инженерство
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Изграждането на доверие изисква много усилия

Знаете ли как да защитите репутацията си?

Действайте етично и отговорно

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Публикуваното изследване трябва да бъде

С високо качество

Точно

Етично

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НА НАУЧНИТЕ ИЗСЛЕДВАНИЯ
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Denmark

Subject to change

Alle dine forskningsresultater er relevante. Tilbagehold dem ikke

Hold dig på evidensens side

Philippe Grandjean

Miljømedicinsk Epidemiolog og redaktør

MEDLEM AF PATH2INTEGRITY FÆLLESSKABET,
FORTALER FOR FORSKNINGSINTEGRITIET
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Germany

Wissenschaft und Gesellschaft basieren auf Vertrauen

Sei offen

Sei verständlich

Sei aufrichtig

Albrecht Beutelspacher

Mathematiker

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FÖRDERER VON INTEGRITÄT IN DER FORSCHUNG
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Glaubwürdigkeit aufzubauen bedeutet viel Arbeit

Weißt du,
wie du deinen
Ruf schützen
kannst?

Handle ethisch und verantwortungs-bewusst

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Psycholinguistin

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Veröffentlichte Forschung muss

qualitativ hochwertig sein

sozial robust sein

ethisch sein

Alexander Gerber

Kommunikationswissenschaftler

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Sei bereit für deine Forschung einzustehen

Mach dich schlau:
Kenne die für dich,
deine Disziplin und
deine Einrichtung
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Poland

Nauka i społeczeństwo zbudowane są na zaufaniu

Bądź otwarty

Mów jasno

Postępuj uczciwie

Tymon Zieliński

Oceanograf, badacz zmian klimatycznych

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Wszystkie wyniki badań są ważne Mów o nich otwarcie

Opowiedz się
za dowodami

Bogusława Dorota Gołębniak

Pedagożka, badaczka edukacji

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Traktuj uczestników swoich badań z szacunkiem i troską

Ludzie · Zwierzęta · Kultura · Środowisko naturalne ·

Justyna Olko

Historyk i socjolingwista, specjalizuje się w rewitalizacji zagrożonych wymarciem języków mniejszości etnicznych

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Opublikowane badania muszą być

wysokiej jakości

rzetelnie opisane

etyczne

Anna Wójcicka

Genetyczka, badaczka nowotworów

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Bądź odpowiedzialny za swoje badania

Zapoznaj się z kodeksem etycznym i regulaminem rzetelnego prowadzenia badań naukowych

European Code of Conduct for Research Integrity:

Tomasz Sulej

Paleobiolog, specjalizuje się w paleontologii triasu

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O PRZESTRZEGANIE RZETELNOŚCI NAUKOWEJ
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Spain
Spanish language

La ciencia y la sociedad se basan en la confianza

Favorece
la accesibilidad,
la claridad
y la honestidad

Joan Massagué

Investigador en Cáncer

MIEMBRO DE LA COMUNIDAD DE PATH2INTEGRITY
EN FAVOR DE LA INTEGRIDAD EN LA INVESTIGACIÓN
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En investigación todos los resultados son relevantes. No obvies ninguno

Sigue la ruta de la evidencia

Marta Macho Stadler

Investigadora en Geometría

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La credibilidad cuesta ganársela

¿Sabes cómo proteger tu reputación?

Actúa de forma ética y responsable

Juan Ignacio Cirac Sasturain

Investigador en Computación Cuántica

MIEMBRO DE LA COMUNIDAD DE PATH2INTEGRITY EN FAVOR DE LA INTEGRIDAD EN LA INVESTIGACIÓN

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Foto: Axel Griesch

La integridad en la investigación fomenta el respeto entre el equipo investigador

Sònia Fernández Vidal

Investigadora en Óptica e Información Cuántica

MIEMBRO DE LA COMUNIDAD DE PATH2INTEGRITY
EN FAVOR DE LA INTEGRIDAD EN LA INVESTIGACIÓN

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Sé responsable de tu investigación

Conoce los códigos de conducta

Código de Conducta Europeo de Integridad en la Investigación:

Avelino Corma

Investigador en Catálisis Heterogénea

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Spain
Catalan language

Subject to change

La ciència i la societat es basen en la confiança

Afavoreix l'accessibilitat, la claredat i l'honestedat

## Joan Massagué

Investigador en Càncer

MEMBRE DE LA COMUNITAT DE PATH2INTEGRITY
EN FAVOR DE LA INTEGRITAT A LA RECERCA
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En recerca tots els resultats són rellevants. No els amaguis

Segueix la ruta de l'evidència

Anna Veiga

Investigadora en Embriologia i Cèl·lules Mare Pluriponents

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EN FAVOR DE LA INTEGRITAT A LA RECERCA
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La credibilitat costa guanyar-se-la

Saps com protegir la teva reputació?

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Foto: Axel Griesch

La integritat a la recerca fomenta el respecte entre l'equip investigador

Sònia Fernández Vidal

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Sigues responsable de la teva recerca

Coneix els codis de conducta

Codi de Conducta Europeu d'Integritat a la Recerca:

Samuel Sánchez

Investigador en Nanotecnologia

MEMBRE DE LA COMUNITAT DE PATH2INTEGRITY EN FAVOR DE LA INTEGRITAT A LA RECERCA

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3 leaflets

Subject to change

Let's preserve research integrity

European Code of Conduct for Research Integrity

What is research integrity?

Research can be understood as a systematic way to gain knowledge that helps us understand our world and develop it. Because of this, research needs to be trustworthy and carried out transparently. In order to guarantee the quality of research and prevent misconduct, research integrity must be established.

Research integrity principles

There are four central principles which must be followed for research integrity:

Reliability
Guarantees that research is done well, with proper design, relevant methods, good data analysis and appropriate resource management

Honesty
Research is planned, performed, evaluated and communicated transparently, fairly and without bias

Respect
For colleagues, research participants, society, ecosystem, culture and environment

Accountability/responsibility
Covers the research process from idea to publication, including management, organization, training, supervision, mentorship and supervision of the wider impact of research

Implementing research integrity: how can I contribute?

There are few things you could do that would help avoid research misconduct and enforce/implement research integrity:

- Always use reliable sources in order to avoid the spread of misinformation
- Properly cite your sources
- Avoid biased information that lowers the quality of your paper
- Counsel your teacher or supervisor for advice if you face challenges during your research

Path2Integrity's role in the context of research integrity

Path2Integrity is a European Union's Horizon 2020 research and innovation programme that raises awareness about research integrity, while educating on how to argue in favour of responsible research and reliable research results. The main goal is to explain how important it is both for you as a citizen and for you as a (future) researcher to have a culture of research integrity. The project aims to:

- establish a culture of research integrity by introducing different integrity role models
- raise awareness of scientific facts about research integrity
- achieve widespread implementation of excellent learning paths
- create units for learning research integrity that address all parties involved in research (students, undergraduates, graduates, young researchers and organizations)

Enforcing research integrity

There are research practices that can either enforce or impede research integrity.

Good practices
Do's

- Establish a research environment where integrity is valued and violations are dealt with

- Promote good and rigorous research process and methods within training, supervision and mentoring

- Use resources reasonably, publishing results with justified interpretations and respecting confidentiality of the information

- Consider the health, safety and welfare of the community and collaborators, showing sensitivity to age, gender, culture, religion, ethnic origin and social class

- Ensure transparency and provide data access that is 'as open as possible, as closed as necessary'

- Take equal responsibility for research integrity among all partners, agreeing on goals and open communication, following codes, laws and regulations, and handling conflicts

- Properly acknowledge all parties involved in the research and openly communicate the results to the general public

- Show commitment in reviewing, evaluating and editing research manuscripts

Bad practices
Dont's

- Fabricate results and present them as real

- Manipulate research material, equipment or process; change or leave out data or results without justification

- Use other people's work and ideas without citing the original sources or giving them proper credit

The importance of research integrity in today's society

Ensuring research integrity can bring significant benefits for both scientists and organizations. The Science Europe Working Group lists seven reasons why you should emphasise research integrity, as it:

- Safeguards the **foundations of science** and scholarship

- Maintains **public confidence** in researchers and research evidence

- Underpins continued **public investment** in research

- Protects the **reputation** and careers of researchers

- Prevents adverse **impact** on patients and the public

- Promotes **economic advancement**

- Prevents **avoidable waste** of resources

2

Path 2 Integrity

www.path2integrity.eu

Let's preserve research integrity

European Code
of Conduct for
Research
Integrity

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- Take a course about good research practice, let your staff members attend such courses as well

- Create a pleasant working environment by discussing and addressing results and challenges

- Let your staff members talk about their errors and mistakes by showing patience and support

- Follow the general principles of research integrity: reliability, honesty, respect and accountability

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Path 2 Integrity

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European Code of Conduct for Research Integrity

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- Provide clear and easily accessible guidelines and policies about research integrity, as well as accessible contact information for responsible persons or committees

- Make research integrity guidelines part of employment agreements and funding contracts

- Offer research integrity training and mentoring throughout researchers' entire career

- Make sure your management is wise, motivating and encouraging

- Facilitate open dialogues and improve work environment and satisfaction

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2

5 thematic overviews

Subject to change

Researcher accountability

Responsibility combats bad research and its negative impacts

Path ● 2 ● Integrity

What is accountability in research?

accountability

noun
UK /əˌkaʊn.təˈbɪl.ə.ti/   US /əˌkaʊn.təˈbɪl.ə.ti/

The fact of being responsible for what you do and able to give a satisfactory reason for it, or the degree to which this happens.

Source: Cambridge Dictionary

Accountability is a "fundamental principle of research integrity", as stated by ALLEA – All European Academies in the European Code of Conduct for Research Integrity (ECoC, Revised Edition, Berlin 2017). Its application spans "from the idea of the research itself to publication ... its management and organization ... training, supervision and mentoring, and ... its wider impacts".

Researchers at all stages of their career are responsible for behaving ethically, being **honest** and **collegial**, and abiding by **principles of research ethics and professionalism**. They are responsible for learning to do **robust (high quality) research** and for assuring that the **methods** and **data** they collect are **reliable and valid**.

According to the ECoC, "a basic **responsibility** of the research community is to formulate the principles of research, to define the criteria for proper research behaviour, to maximize the quality and robustness of research, and to respond adequately to threats to, or violations of, research integrity."

Principles of good research practices

- Reliability in ensuring the quality and rigour in the research design, methodology, analysis, and use of resources.

- Honesty in developing, undertaking, reviewing, reporting, and communicating research in a transparent, fair, full, and unbiased way.

- Respect for colleagues, research participants, society, ecosystems, cultural heritage, and the environment.

Source: ECoC

Accountability: from research institutions to individual researchers

Although in some regions of the world researchers are required to take courses in research ethics and good scientific practice before they can start their research, that is not the general rule. Nonetheless, **research institutions and organizations** should promote **awareness** and ensure a prevailing **culture of research integrity**, providing **guidelines** with **clear policies** and **procedures** on good research practice.

Research institutions and organizations must also provide researchers with the **infrastructure**, such as special tools or data management platforms, needed for managing and protecting the data and materials to ensure reproducibility, traceability and **accountability**.

The **challenge** research institutions must deal with is securing adequate budgets and

infrastructures to support proper data management, including data security.

In research, pressures to obtain and publish results can be high. Thus, all researchers need to learn to handle the **pressure** coming from their superiors, affiliated institutions, funders, colleagues, and competitors, in order to avoid falling into any temptations they may have regarding research misconduct or poor practices.

Regardless of the research field, and despite the pressures, all researchers have the basic responsibility to be honest, comply with ethical standards, collect

robust data, and endeavour to reach valid conclusions.

Aside from the research team's personal and collective responsibility and the institutional responsibility of the centre, there are some aspects in which **the principal investigator (PI) has the most responsibility** as the senior-most member of the team with the most knowledge and experience.

How to be accountable:

If you are a PI:

- Know **deeply about research** and **intellectual property regulations** in the jurisdiction where your team is doing research and be sure the study complies with the relevant legislation and organizational policies. Intellectual property can include words and ideas, which can be relatively easy to steal from others. In this sense, properly citing others' work and acknowledging authors and inventors for their intellectual contributions is ethically appropriate.

- Be sure that ALL authors are aware of **conflict of interest** policies and financial or other types of support related to the research project. Make sure that ALL the researchers in the team know who has a conflict of interest and ensure that these conflicts are disclosed, especially on grant applications, presentations, and publications. In this sense, researchers are often rewarded for their talents in various ways, including money, private consulting contracts, royalties, etc. Having multiple **rewards** can bring personal fulfilment, but these rewards can also potentially **impact decisions** pertaining to research design, data analysis, and data presentation.

- Be fully aware of **each author's contributions** to a paper. In all fields, acknowledgments should be duly given to those not satisfying authorship criteria.

- Make sure **authorship is discussed and planned** for the papers that the lab/group is working on, as well as for patent applications.

- Be aware of **who the research team is dealing with** when performing research and collaborating with other scientific teams, and **what sort of information they are exchanging**, to monitor compliance with relevant laws and regulations.

- Consider that some **technologies** can seem neutral but can be applied or further developed for uses that harm society or the environment. Therefore, researchers should be reflective and sensitive to the ethical complexities of their research and take steps to mitigate **risks of current and future use** whenever possible.

- **Train junior researchers** in good research practice, applying the principles of accountability mentioned here. In turn, junior researchers are expected to proactively learn about and adhere to these responsibilities.

- Often a grant-holder, you are responsible for the **funds allocated for a specific project**. If equipment was loaned for a study or a project, you must secure loan agreements or similar contracts for that equipment. You should also be fully aware of export control issues.

- **Ensure project close-out**, including results dissemination and data archival.
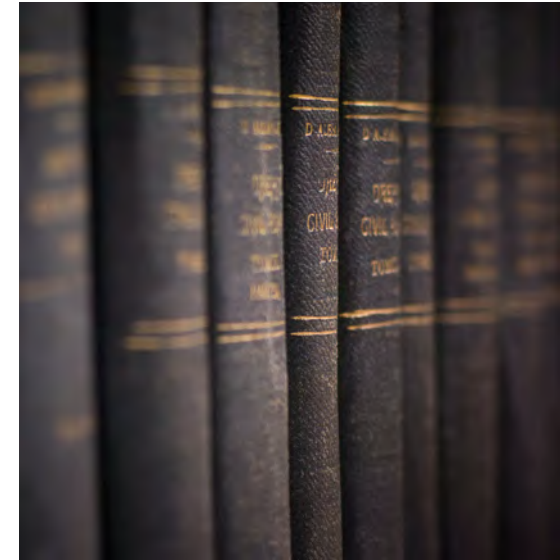
If you work in the lab:

- The PI is responsible for **lab safety** to minimize the risk of accidents. The PI needs to make sure all health and safety regulations are met and that all the researchers in the team are trained and follow those guidelines. For instance, in the case of biomedical labs, researchers must wear goggles, lab coat, and gloves.

- In all labs, regardless of the field of knowledge, emergency exits must be free to enable evacuation. In the event something goes wrong, all researchers must know the location of the safety equipment and how to use it.

- All researchers must be fully aware of the hazards of the materials they will be using.

- In the case of working with lasers, nobody should ever look into it, even if it is supposedly eye-safe or low power. Appropriate goggles are to be worn in areas where lasers are present. Moreover, researchers must keep always the laser beam at or below chest level.

- In labs containing electronic equipment, all researchers should follow electrical safety rules in order to help prevent the misuse of electronic instruments, electric shocks, and other injuries. In addition, all researchers should be sure that any damaged equipment, cords, or plugs are reported so they can be repaired or replaced.

- In the case of biomedical resources, all researchers should be trained in animal welfare before being allowed to work with live animals in the lab. Institutions generally have an animal ethics committee or animal welfare committee along with animal welfare protocols.

- No food or drinks can be consumed in the lab, nor should they be stored in the same refrigerator containing experiments, chemicals or cultures.

If you are a research institution:

- Do not take advantage of your researchers. Duly compensate them, including with suitable renumeration and promotions according to their performance.

If you are any other researcher:

- Manage and disclose your conflicts of interest so they do not introduce any suggestion of bias in your work. Learning and applying good research integrity practices can minimize bad research and impacts, ensuring trust in and appropriate public recognition of your work and results.

- Know how to dispose of experimental materials when finished. In this sense, you are accountable for research and lab safety and adverse event reporting in your work. You are accountable for mitigating risk and fostering safety and welfare in other participants.

- **Reflect** on the **ethical sensitivity of your research**: this means considering whether the technologies under development could have a dual use; the context of the use of the technology; and whether research outputs will be accessible to vulnerable social groups.

As an author:

- Do not be bullied into giving honorary authorship to please others that have not made any substantial contribution to the research.

- Do not accept honorary authorship as a valid way to build your CV.

- Have the moral courage to respect the gold standard of authorship (the ICJME requirements, applied across all domains of research).

Make it part of your DNA!

- Be honest
- Behave ethically
- Be collegial
- Maintain research ethics and professionalism
- Perform robust research: collect robust data
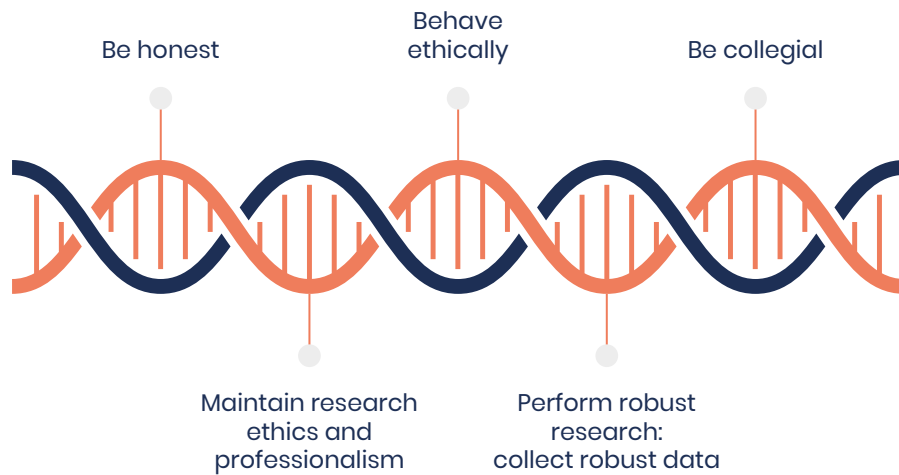
In the lab, have you checked if...

- All the expired reagents and materials have been discarded?
- Lab notebooks are reviewed and signed?
- All team members know how to use back-up emergency power?
- Trainings are up-to-date?
- Loan agreements are on file for all loaned equipment?
- There is clear access to exits, eyewash stations, fire extinguishers, and other emergency equipment?

Source: Luxembourg Agency for Research Integrity (LARI)

Authors: Cristina Sáez, Katrina Bramstedt [Luxembourg Agency for Research Integrity & Bond University Medical Program]

This Accountability of Researchers overview is part of the Ethical Researcher series developed in the framework of the Path2Integrity project, a European Union Horizon 2020 research and innovative programme that raises awareness about research integrity, while educating on how to argue in favour of responsible research and reliable research results. The main goal is to explain how important it is for researchers and society to sustain a culture of research integrity.

Please, also check the following overviews on:

Mentorship

Publication

Research Environment

Transparency versus protection of data and results

Research Integrity

Is the **quality safeguard** of science and technology, the social sciences, and the humanities.

Protects the **reputation** and careers of researchers and research organizations.

Contributes to **social progress, trust and accountability** in science and technology, the social sciences, and the humanities.

Avoids negative **social impacts** and wasted resources, time, and efforts.

www.path2integrity.eu

Path 2 Integrity

Research environment

Research integrity protects the reputation and careers of researchers and organizations

Path 2 Integrity
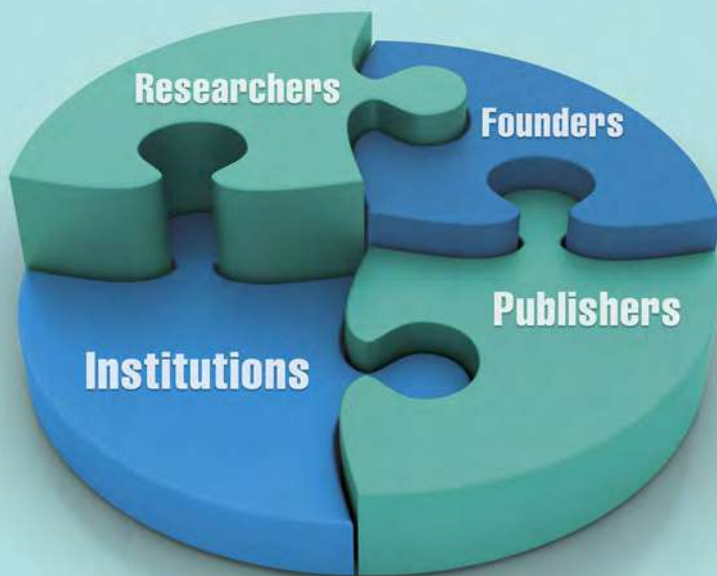
Definition

Instead of a blurry definition of actions in the research environment to foster research excellence, let's start with the research culture or climate and the way researchers are assessed. Science and research aim to advance knowledge to its own and society's benefit. To do so, that knowledge needs to be trustworthy, which means robust, rigorous, and transparent at all stages of design, execution, and reporting. Thus, research evaluation plays an important role in developing research results and shaping their impact on society.

In that sense, myriad stakeholders take part in research evaluation, from institutions such as universities and research agencies with supervisors, mentors and codes of conduct; to researchers with research integrity training; scientific publishers like editors, authors and peer-reviewers; funding agencies; and whistleblowers or regulatory agencies.

Excellent research environment

Maintaining an excellent research climate, though challenging, can be achieved through a collaborative and transparent approach, wherein publishers, researchers, institutions, funders, and metrics providers act responsibly to positively change it.

In this sense, there are some helpful initiatives like the San Francisco Declaration on Research Assessment (DORA) and the Leiden Manifesto, which place an emphasis on assessing research based on trustworthiness, rigour and transparency. They have developed guidelines with principles and recommendations to improve how research is evaluated in hiring, promoting, and funding decisions.

The 10 principles of the Leiden Manifesto:

1. Quantitative evaluation should support qualitative expert assessment.

2. Measure performance against the research missions of the institution, group or researcher.

3. Protect excellence in locally relevant research.

4. Keep data collection and analytical processes open, transparent and simple.

5. Allow those evaluated to verify data and analysis.

6. Account for variation by field in publication and citation practices.

7. Base assessment of individual researchers on a qualitative judgement of their portfolio.

8. Avoid misplaced concreteness and false precision.

9. Recognize the systemic effects of assessment and indicators.

10. Scrutinize indicators regularly and update them

The Hong Kong Principles for Assessing Researchers, presented at the 6th World Conference on Research Integrity, put a specific focus on ensuring that researchers are explicitly recognized and rewarded for behaviour leading to trustworthy research.

Hong Kong principles:

- Responsible research practices
- Transparent reporting
- Open science and open research
- Valuing a diversity of types of research
- Recognizing all contributions to research and scholarly activity

Institutions can make a difference in how they assess candidates when hiring them, or how they promote and reward their researchers.

For individual researchers, changing a research environment can be difficult, but not impossible. Some things they can do in order to achieve it are:

- Addressing issues
- Talking about the dilemmas
- Supervising responsibly

Assessing more than the scientific output

The [University Medical Center Utrecht](#) (Netherlands) is trying to positively change the research environment. To appoint new professors, they require applicants to submit a portfolio with their teaching activities, evaluations, and societal contributions, in addition to their scientific output. The whole portfolio is assessed when considering promoting researchers to full professor. The process is longer but considered fairer since it allows the appointment of a more diverse group of people.

Funders can also play a key role in ensuring a healthy research environment by changing their funding criteria: they can take into account the content and skills of the researchers and not only the output from earlier projects. A good example is [the Wellcome Trust Foundation](#), which is advancing in that direction. Their website states:

"*We want to help build a better research culture, one that is creative, inclusive and honest. Current practices prioritize outputs at almost any cost. This is damaging people's wellbeing and undermining the quality of research. We can all help to reimagine how research is conducted*".

Journals, too, have a strong influence on this. Nowadays, there is growing concern among researchers about how publication in journals is used for evaluating research. Many regard these evaluations as having a negative impact on scholarship, as it introduces perverse incentives.

Some journals have already started to abandon the promotion of the journal impact factor, such as eLife or PLOS; other publishers, like the Royal Society or Nature Research, choose to put the journal impact factor in the context of a broad range of journal metrics, showing how different journal metrics have different values.

Research culture is not only the culture of the researchers, but the culture created with all the stakeholders. And it is a global thing, involving all countries.

Challenges for the research environment

Modern research culture assesses researchers mostly by their numbers, so the pressure to publish is strong. To some degree, this can incentivize high-quality research, but when that pressure is heightened, it may have detrimental effects both on research and its professionals: they feel they must publish in high impact factor journals to increase their chances of getting funded or promoted.

As stated in a 2019 PLOS ONE article, 'Perceived publication pressure in Amsterdam: Survey of all disciplinary fields and academic ranks', by Tamarinde L. Haven, Lex M. Bouter, Yvo M. Smulders, Joeri K. Tijdink: "an excessive publication pressure is linked to poor quality research and teaching, a decreased willingness to share raw data, less involvement from researchers in public and policy issues, and less academic creativity. The perceived hypercompetition is thought to lead to less rigorous ('rushing to print') and less reliable science. Publication pressure is associated with a greater likelihood to engage in research misbehaviours".

Some of those research misbehaviours corrupt findings and conclusions and can consist of fabrication, falsification, and plagiarism, among others. Besides that, other types of questionable research practices can happen, such as salami slicing, gift authorships, or intuitively deleting data.

Publication pressure can also have detrimental effects on individuals: it is associated with emotional exhaustion and susceptibility to burnout. Young researchers usually experience more publication pressure than their senior counterparts.

Although challenging, it is necessary to foster a healthy publication environment where researchers feel supported to focus on the quality and integrity of their research. In this line, initiatives like repositories for papers are helpful and can also have a positive influence on the research culture.

Researchers' personal contribution to a good environment

While it is clear that institutions should take the lead in changing the way they assess researchers, researchers themselves can instigate change by talking about the issues, dilemmas, and difficulties they come across. These may not necessarily be mistakes; sometimes something happens and can cause a problem that researchers have to deal with. Whereas the emergence of a dilemma is often not the researcher's fault, poorly dealing with the consequences of their decision in a responsible way can be.

To solve this, it is important that researchers team up and – if necessary - blow the whistle together. And that requires a more open culture, with protection and systems in place so that people can get advice and support, and share their worries with a confidential counsellor – not just file a complaint.

Whistleblowing is a way to actively report misconduct. Depending on the strength of an institution's whistleblower protections, people will feel encouraged to inform on misbehaviors or decide to passively witness a potential integrity breach.

Thus, whistleblowers should get protection. That protection does not only affect researchers but also any individual or group that may be indirectly involved in conducting research. It is a key element in an institution's ethics code and supports the culture of scientific integrity within an institution.

Whistleblower protection differs widely among institutions and countries. For instance, universities in the UK have developed a specific whistleblowing policy for different misbehaviors, such as grievance, bullying or harassment, whereas in the US the Whistleblower Protection Enhancement Act of 2012 guarantees protection for federal employees who call attention to waste, fraud, and abuse in government operations.

Feel relief, share it with your colleagues

Talking and discussing issues, rather than just silently suffering them, is key to opening up the culture. Teaming up, talking and, if needed, whistleblowing, can improve many situations, not only when dealing with a dilemma or difficult results, but also when trying to balance work and personal life.

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This Research Environment overview is part of the Ethical Researcher series developed in the framework of the Path2Integrity project, a European Union Horizon 2020 research and innovative programme that raises awareness about research integrity, while educating on how to argue in favour of responsible research and reliable research results. The main goal is to explain how important it is for researchers and society to sustain a culture of research integrity.

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Path 2 Integrity

Mentorship in research

Assuring that research integrity principles are followed in research organizations

Path 2 Integrity

What are the criteria for good mentoring?

Although there is no set formula for mentoring, the research community generally agrees that, to be a good mentor, senior researchers should:

- Find a balance between independence and guidance, giving young researchers the freedom to expand on their ideas while gently reining them in when they get off track. In this sense, a special challenge is how to nurture research creativity while encouraging independence.

- Find a way to exert appropriate control without directing every single step young researchers may take or criticizing and questioning everything they do. In all cases, they should avoid misusing their power.

- Be good listeners and questioners as well. Instead of merely providing answers to young researchers, senior ones should lead them towards both an answer and a better understanding of what they are learning through more questions.

What is mentorship?

In Homer's Odyssey, Odysseus commissioned his friend Mentor to watch over his son, Telemachus, while he was away fighting in the Trojan War. The word 'mentor' has since evolved to mean an "experienced and trusted person who gives another person advice and help", according to Cambridge Dictionary.

In research, mentoring refers to good supervision, which implies overseeing young researchers' work while also granting them enough freedom and scope to support their professional development.

Subject to change

- Be willing to provide opportunities for practical learning, including through mistakes, since these can be turned into good teachable moments.

- Be willing to teach general ethical values and principles of research, beyond the standards of specific disciplines, such as honesty, transparency, accountability, openness, and objectivity. Mentors should also raise awareness of the pitfalls of scientific misconduct. Research integrity should guide all researchers, regardless of their field.

- Be aware of their influence as role models to their PhD students' careers, in order to motivate them to someday be good mentors and supervisors themselves.

The importance of celebration

Both mentors and mentees should appreciate the value of celebrating victories, both large and small, as it is highly encouraging and can also contribute to community building, key to creating an environment where every researcher can thrive.

For their part, in order to be well mentored, young researchers should:

- Be willing to learn from senior researchers and consider and heed their advice.

- Respect agreements regarding certain steps of the work in their respective disciplines.

- Be willing to develop their own ideas and projects, and to use the scope and the freedom of research in an appropriate way.

- Be (come) aware of research and personal accountability.

What the best mentors are like

A 2018 Nature survey in the scientific community tried to find out what the distinctive features of good mentors were. In a nutshell, these are:

- **Enthusiasm:** Mentors should be enthusiastic about their young students' research. If they are not, they need to ask themselves whether the student is working on the right project. If mentors are not passionate about their project, can they properly support them?

- **Empathy:** Mentors should show compassion and understanding. They need to listen, hear, and support their mentees' professional and non-professional needs, such as finding the right balance between work and family responsibilities.

- **Appreciate individual differences:** Mentors should strive to understand all team members and provide tailored help to each to enable them to make decisions about their career directions.

- **Respect:** Mentors should treat young researchers as genuine collaborators.

- **Unselfishness:** Mentors should let their students develop their ideas and allow them to be lead authors. They should also introduce mentees into their networks, for example, to facilitate potential collaborations.

- **Availability:** This is the standout quality appreciated by the mentees. Despite enormous workloads and responsibilities, mentors' doors should always be open. Regular meetings are clearly an important way for many mentors to support their scholars.

How to foster mentorship?

Senior supervisors are expected to be mentors for young researchers. However, there are currently no clear or binding criteria for mentorship, nor are mentors properly trained to play this role. Therefore, some guidance for how to appropriately supervise junior researchers' work is advisable:

- Universities, institutions and even funding programmes should encourage written binding agreements covering the rights and duties of both supervisors and PhDs. In most German universities, for example, senior and junior researchers have a written agreement establishing rules about what the project is, what has to be done, what it is expected, and when project milestones should be complete, among others. However, there is still room to more fully exploit the potential of these instruments in practice.

- Awards for good mentoring and supervision could foster discussions around these relationships and promote the development of certain criteria. Likewise, awards can help raise awareness on good role models in mentoring. It would also be helpful to consider mentorship as a merit on senior researchers' CVs.

- Training young researchers is fundamental as well. Mentees can potentially challenge or change poor supervisory practices they experience. Good mentors should also encourage their students to start learning skills that will benefit them in the long term as soon as they start their PhD, such as being good communicators, for instance. Young researchers too, can be inspiring for undergraduate students who may someday become their future mentees.

Authors: Cristina Sáez, Helga Nolte [CoachInScience]

Images: iStock by Getty Images

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Path 2 Integrity

Towards excellence in scholarly records:

publishing, reviewing and editing

Research integrity ensures that reporting and communicating results is done transparently, fairly, and objectively

Path2Integrity

How to choose a journal

Sharing your research results with the rest of the research community is key to advancing your discipline and your career. Nevertheless, the increasing number of publications launched every year, together with the rise in publisher malpractice and deception, can make it really **challenging to choose a trustworthy journal** for your research.

Before choosing a journal to submit your manuscript:

● Be sure that it is a trusted journal and its scope is right for your work;

● Be sure that the chosen journal will help you enhance your reputation and your chance of being cited and, ultimately, progress in your career.

● Make sure your paper is indexed and easily discoverable.

Open Access journal or traditional journal?

This is not the most important question to ask yourself. Your first goal must be to **publish in a good journal** – the best for your interests. To do so, it is advisable to **assess the risks and benefits** of publishing in different ways. Only then should researchers consider the **publishing fee**.

Lately, there is growing interest within the European Union in **open access**, which favours increased funding for open-access research.

From the researcher's point of view, authors are the owners of their open access articles, not the journal. In fact, the whole open access movement and the creative common licenses for open access were put in place precisely to reclaim academic ownership of what researchers publish.

From the societal point of view, publishing in an open access journal adds transparency and gives the public the opportunity to find and use the information. For instance, in the case of clinical trials, a person can go to a registry like ClinicalTrials.gov and see the results of the clinical trial they are interested in as a patient.

In subject areas where information is really important for the public, or in the case of a public emergency, articles tend to be open access, available to all researchers and the public. An example for that is the coronavirus outbreak.

In fields other than the health sciences, commercial interests are sometimes a burden in this sense. Nevertheless, transparency in research results is important so that people can see it, check it and reproduce it, so that no research is wasted.

Beware of predatory journals!

Predatory journals are on the rise: these are fake journals that are not indexed and do not have a proper peer review process. Often, they have names that are very similar to reputable journals; they even look like them and post all kinds of metrics, like the global impact factor, which makes it challenging not only for young researchers but also sometimes even for an experienced researcher to recognize them.

To verify:

- Check whether your colleagues know the journal, have read any articles in it, and whether it is easy to find the latest papers in the journal.

- Check if you can easily identify the publisher and their contact information, and whether they are a member of a recognized industry initiative, such as the Committee on Publication Ethics (COPE).

- If it is an open access journal, check whether it is listed on the Directory of Open Access Journals (DOAJ); belongs to the Open Access Scholarly Publisher's Association (OASPA); hosted on one of INASP's Journals Online Platforms (for journals published in Bangladesh, Nepal, Sri Lanka, Central America and Mongolia) or on African Journals Online (AJOL, for African journals).

- Check if you recognize the editorial board members; if it is clear what type of peer review it uses and what fees will be charged, when and what for.

Only if you are satisfied on most or all of these questions can you be confident that the journal is not predatory and feel safe in submitting your article.

Source: thinkchecksubmit.org

Review process

When submitting a paper to a journal, you should expect a professional publishing experience where your work is reviewed and edited. According to Tony Ross-Hellauer in his paper "What is open peer review? A systematic review", published in F1000Research, "peer review is the formal quality assurance mechanism whereby scholarly manuscripts, such as journal articles, grant paper or conference papers, are made subject to scrutiny of others, whose feedback and judgements are then used to improve works and make final decisions regarding selection." Peer review serves two main functions, he continues, "technical evaluation of the validity or soundness of a work in its methodology, analysis and argumentation and assisting editorial selection by assessing the novelty or expected impact of a work".

Review processes

Post-publication review

The article is published, then reviewed, and only the final version of the article is considered to be the final version that is indexed. Everything is visible online, even for papers that are ultimately rejected, including the names of the peer reviewers, what they said and when, how the authors responded, and so on.

Open peer review

Can take several forms. It may be a process where everything is known from the beginning but is not published; or only the names may be published but not the review; or the reviews can be open and published but not the names of the reviewers.

Blind review

Peer review can be single-blinded, the standard in biomedicine, in which the reviewer knows the names of the authors but not the other way around; or double-blinded, which is very common in the humanities and social sciences, wherein neither the reviewer nor the author knows who the other party is.

Results-free peer review

Reviewers first examine the methodology and approach of the research, and if they approve it, authors can submit the paper to the journal when they have the results, which is then almost accepted for publication.

Consultative review

Reviewers talk to each other during the peer review process; they have a panel, there is discussion, and the authors get a kind of final consensus review from the individual reviewers and the editors.

While an **open peer review** process adds transparency and accountability to research, it **seems to be easier in STEM disciplines** than in the humanities and social sciences, where opinion and intellectual arguments are in play in addition to objective data.

A **substantial barrier to overcome** in open peer review is the **concern held by reviewers**, especially when they are young researchers, about criticizing colleagues' work, especially that of established researchers. They fear it could affect their career.

Another challenge is **transparency in the system**. Even in journals where the peer review process is transparent, readers can only see what is published, not what has been **rejected or the reasons for rejection**. The only fully transparent journal in that sense is F1000Research.
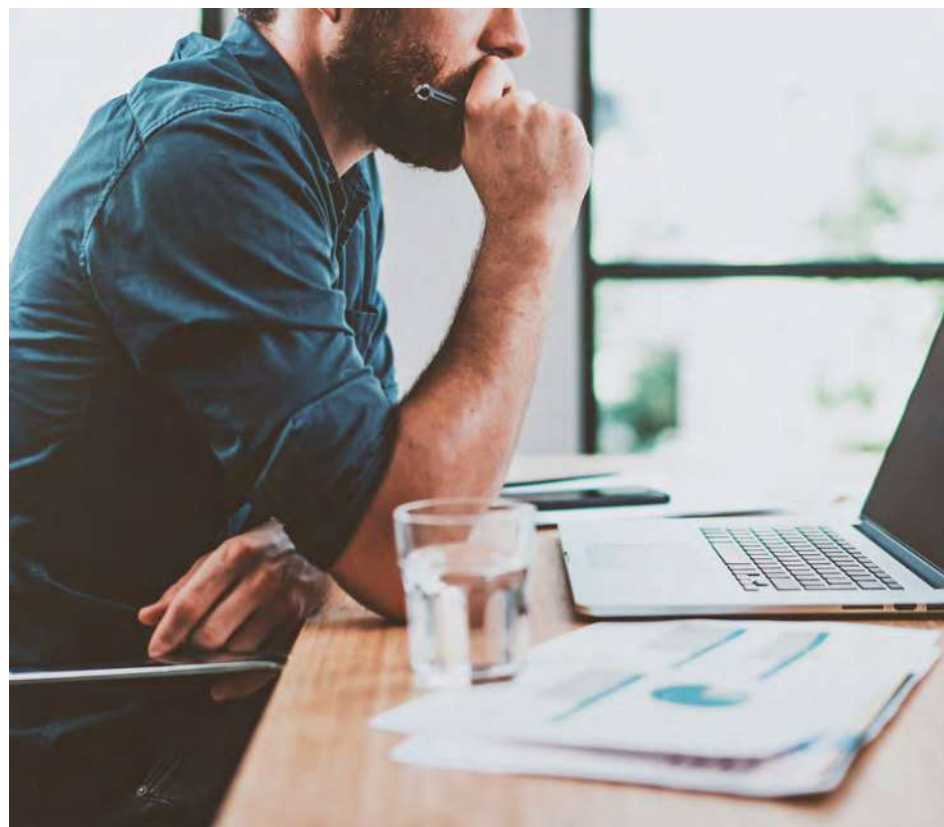
For editors and publishers

Editorial decisions – do editors have competing interests? Openness of their decision-making

As researchers do when authoring a paper, journal editors should declare any financial or non-financial conflicts of interests. According to Ana Marusic and Rafael Dal-Ré in "Getting more light into the dark room of editorial conflicts of interest", Journal of Global Health, June 2018, "the transparency of disclosure of the publisher [conflicts of interest] has not improved across journals from a range of disciplines and influence in the scientific community in the last 12 years, despite greater awareness and the published evidence about the problem ...

Editors who received industry payments, regardless of the amount, can make biased decisions, too, although sometimes in the opposite direction to the expected one".

In order to add transparency and openness to their decision making, journals should publish clearly editorial conflicts of interest for the publication itself and for its individual editors. These conflict of interest declarations should be visible and properly indexed to make them easily identifiable in bibliographical databases.

For publisher and researchers

How to deal with allegations of misconduct in a journal

Although the standards for authorship are that all researchers are responsible for the whole article, usually there is a guarantor, a person who is responsible for the overall integrity of the paper and accepts responsibility in case of misconduct.

Correcting the published record

According to COPE, an institution in publication ethics, journal editors should consider retracting a publication if they have clear evidence that the findings are unreliable due to misconduct, falsification, or honest error.

Journals should also watch out for findings that have previously been published elsewhere without proper attribution, permission or justification; plagiarism; unethical research; a serious legal issue; or a major competing interest that authors failed to disclose. Papers published on the basis of a manipulated peer review process may also merit retraction.

If a journal or a group of authors do decide to retract an article, the news of the retraction should clearly identify the retracted article and be made available to all readers wherever possible. It is important to state who is retracting the article and the reason for retraction.

In the era of collaborative science, in which research groups are large, it is increasingly challenging to assess the integrity of the paper. In this sense, electronic data management and exchange enables greater checks and more awareness. This quality control is essential in order to prevent either intentional or unintentional mistakes.

In the case of allegations of misconduct in a journal, or a mistake detected, a correction can be issued. If the mistake gave rise to erroneous conclusions, the article should be retracted; some journals allow retraction with replacement.
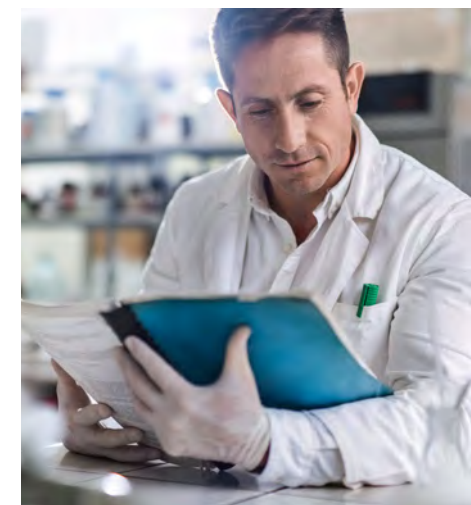
Authors: Cristina Sáez, Ana Marusic [University of Split. School of Medicine. Croatia]

Images: iStock by Getty Images

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Path 2 Integrity

Transparency in research:

principles, guidelines, and limits

Research integrity ensures that research work is accepted, can be used by others, and is respectful of study participants

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Path 2 Integrity

What is transparency in research and where can I find guidelines?

Applying [Cambridge Dictionary's definition](#), transparency in research can be defined as research activities and processes that are done openly, without secrets, so that other colleagues and the public can trust that they are fair and honest.

The four pillars of research transparency

- Registering research
- Publishing and disseminating findings and conclusions
- Granting access to the data and samples used in the research
- Providing information at the end of the research to participants

Source: NHS

Local and international guidelines and codes consider the issue of research transparency in different ways. For instance, Article 5.1 of the [General Data Protection Regulation (GDPR)](#), in the European Union framework, establishes 'transparency' as **one of the principles relating to the processing of personal data**: "Personal data shall be processed lawfully, fairly and in a transparent manner in relation to the data subject".

In its [Recital 39](#), the EU further states that individuals should know how "personal data concerning them [is] collected, used, consulted or otherwise processed and to what extent the personal data are or will be processed".

Other key aspects related to transparency are discussed in different international initiatives. One of these is the [FAIR Guiding Principles for scientific data management and stewardship](#), published in 2016 in Scientific Data, that tries to provide guidelines to make research findable, accessible, interoperable, and re-usable.

Data, analysis and production

Research transparency [encompasses three dimensions](): data, analysis, and production.

- Data transparency: researchers should make the evidence or data used to support their research and claims available to readers. "This permits readers to appreciate the richness and nuance of what sources actually say, assess precisely how they relate to broader claims, and evaluate whether they have been interpreted or analyzed correctly".

- Analytic transparency: researchers should make information about data analysis accessible. Readers should be able to check the interpretive process by which an author infers that evidence supports a specific claim.

- Production transparency: readers should be granted access to "[i]nformation on methods by which particular bodies of cited evidence, arguments, and methods were selected from among the full body of possible choices".

Source: [Andrew Moravcsik, Princeton University]()

The **EQUATOR network** seeks to improve the reliability and value of published health research literature and [offers guidelines]() for transparent and accurate reporting for many study types, from randomized trials to case reports and study protocols. It is very comprehensive source, with a highly detailed, searchable database of reporting guidelines.

There is also an [international initiative committing to research transparency](), which guides and encourages transparency and openness in research. The initiative is addressed to researchers, reviewers, PhD students, committees and editorial boards, and it promotes the values of Open Science. In the case of researchers, they support making raw data and reproducible data analysis scripts available, describing all data elaboration decisions, and encouraging all authors to act in line with these principles.

Because researchers are using more and more computational tools to deal with huge amounts of data, the principles emphasize the "machine-actionability", that is, according to the definition provided by [the GO Fair Initiative]():

"The capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention".

The [Transparency and Openness Promotion (TOP) Guidelines](), published in 2015, provide a suite of useful tools to promote transparent research. They include eight modular standards: (I) citation; (II) data; (III) analytic methods and (IV) research materials transparency; (V) design and analysis transparency; (VI) preregistration of studies; (VII) preregistration of analysis plans; and (VIII) replication. These allow flexibility in their adoption, as they depend on the disciplines, but at the same time, they establish community standards.

Be transparent!

Make sure your research is:

Concise, clear, and easily accessible; written in plain language if possible, and available orally upon request.

In your team, try to cooperate with your colleagues to make the data as sound as possible. This protection of the primary data is key. All the researchers in your team should have access to these primary data, which should be protected for at least 10 years.

The importance of transparency in research

- Transparency enables others to evaluate, re-use, and trace the origin of data, and it should be preserved throughout the research data management cycle. In this sense, as stated in a recent article in PLOS Biology, "data sharing is a critical component of research transparency … as it allows independent investigators to explore new hypotheses, synthesize evidence across studies, and implement the same experimental methods using the same data".

- Transparency can foster the re-use of and further investigation of the data collected, and it increases the availability of digital data for future generations of researchers. Transparency is closely linked to the digitalization process, allowing researchers to cooperate, use and re-use data in a new and possibly more effective manner.

- **Some EU and national funding schemes either strongly advise or require researchers to be transparent.** Following research integrity guidelines, including those related to transparency, is an efficient way to ensure projects are well managed and also to improve your funding success.

- Transparency is strictly linked to **open science initiatives**, and the open science paradigm is increasingly more present in research. It is also essential in processes such as open collaboration and open peer review.

Most national research funding organizations in Europe are expected to ask researchers to publish their results in open access in the near future. This requirement will pose challenges regarding competitors in other countries. For instance, the language of publication (usually English) allows heavy re-use of research results worldwide, whereas most research done in Asia is not translated into English, preventing European researchers from accessing it.

Thus, there are many international initiatives, such as the World Conferences on Research Integrity, that try to promote exchange of information and discussion about responsible research conduct.

Another challenge is **conflicts of interests**, both financial and private. If a researcher is asked to peer review an article written by a colleague, this is a personal conflict of interest. The main guideline is simply to declare that a conflict of interest exists. For instance, if a researcher is attending a conference, they should inform the organizers if they have a conflict of interest, especially if the researcher is publishing an article. Some journals have already started to ask for declarations of non-financial conflicts of interest.

As if these reasons were not convincing enough, researchers' self-interest is also at stake, as Florian Markowetz (University of Cambridge, Cancer Research UK Cambridge Institute) argues in his article, 'Five selfish reasons to work reproducibly'. (Genome Biol 16, 274 (2015). https://doi.org/10.1186/s13059-015-0850-7)

Balancing transparency and privacy

A challenge is how to make the data more transparent but, at the same time, to protect intellectual property rights and respect copyright while also safeguarding security issues around certain disciplines and research domains.

Building a good research culture

Even without any binding laws or specific regulation on transparency, except for data protection within the GDPR, the research community should work together and be responsible for building a research culture that is more open, transparent, and self-regulating.

In the absence of a European or national agency on research integrity and scientific misconduct, it is advisable, helpful and effective for researchers to encourage each other to follow transparency guidelines.
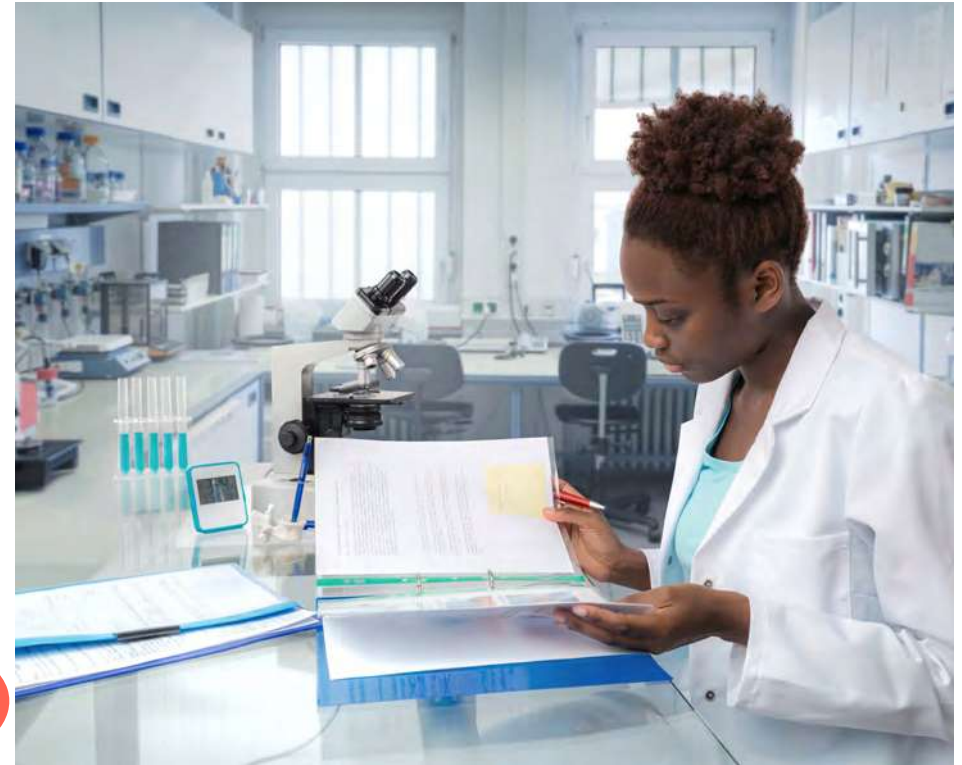
The limits of transparency

According to Karen EC Levy and David Merritt Johns, researchers at Data & Society Research Institute and Cornell University, (New York) data transparency is also subject to limitations. First of all, open processes involve substantial amounts of time and money, so they may be associated with resource shortages. Sharing huge data sets and samples, for instance physical materials, can likewise be difficult or impossible in a practical sense.

There are privacy concerns as well. In the era of big data and artificial intelligence (AI), study participants may be concerned how their sensitive personal data

is handled. Most national laws restrict and strictly regulate the use of these data, and when researchers work with sensitive data, they can anonymize or store them carefully. However, in the case of an automated system working with huge amounts of information, these safeguards can be difficult. The AI tool processes data, uses them, and reuses them, making decisions in a context free of regulations. This is a challenging emerging field that will soon need to be regulated.

Moreover, other types of sensitive information, such as trade secrets, are also a source of constraint.

Some researchers are afraid their ideas might be stolen or that others will publish them first. They may also be afraid other researchers could benefit from using shared data or material without putting in appropriate effort, as highlighted by Elizabeth Gilbert, postdoctoral research fellow in psychiatry and behavioral sciences, Medical University of South Carolina, and Katie Corker, assistant professor of psychology, Grand Valley State University in an article in *The Conversation*.

Thirdly, "epistemological limitations constrain data-driven political decision-making. Agencies charged with protecting public health and the environment must make decisions in the face of scientific uncertainty, because science by its nature is incomplete and only rarely provides precise answers to the complex questions policymakers pose".

Authors: Cristina Sáez. Reviewer: Teodora Konach [Austrian Agency for Research Integrity, OeAWI]

Images: iStock by Getty Images

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11 videos with role models

BULGARIA

Dr. Bliznakova

https://youtu.be/eugOYxJv_LA

DENMARK

Dr. Grandjean

https://youtu.be/DLgN0yBMlA8

GERMANY

Dr. Beutelspacher
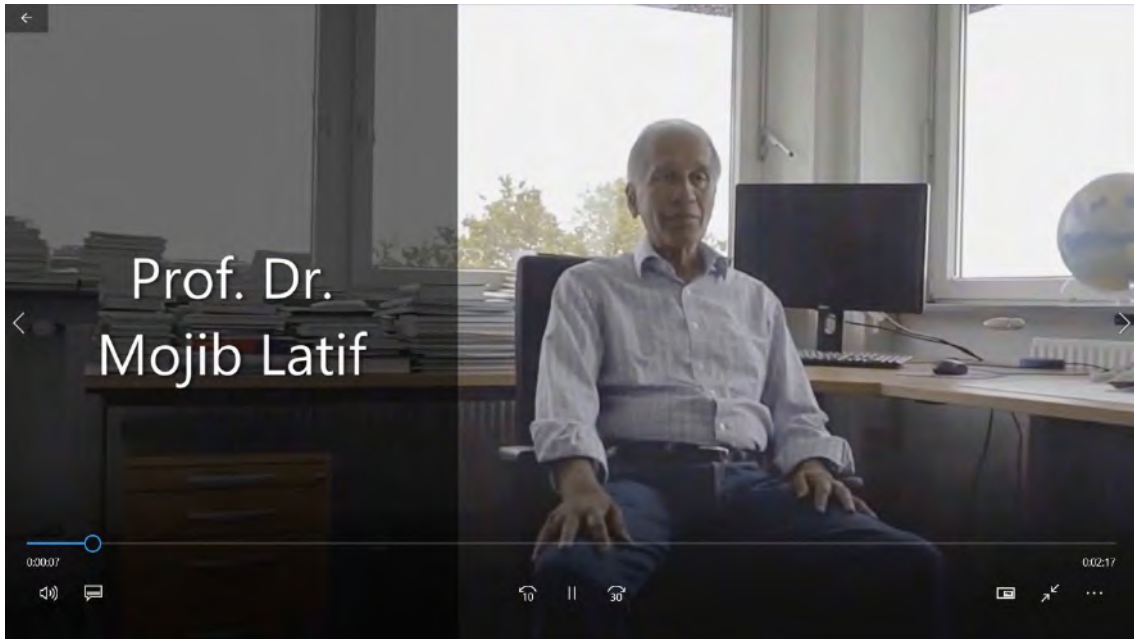
https://youtu.be/IkJO9rX79IQ

Dr. Gerber

https://youtu.be/OsX53M68aaA

Dr. Latif

Dr. Leptin

Dr. Schröter

https://youtu.be/CWec6fD5Vuo

POLAND

Dr. Golebniak

https://youtu.be/_Cu-HahHrr4

Dr. Olko

https://youtu.be/_kewN9vrhJ4

Dr. Sulej

https://youtu.be/ObgWqB99WSA

Dr. Wójcicka

https://youtu.be/DtyRhdygzyQ

Dr. Zielinski

https://youtu.be/vyYdT457BtA
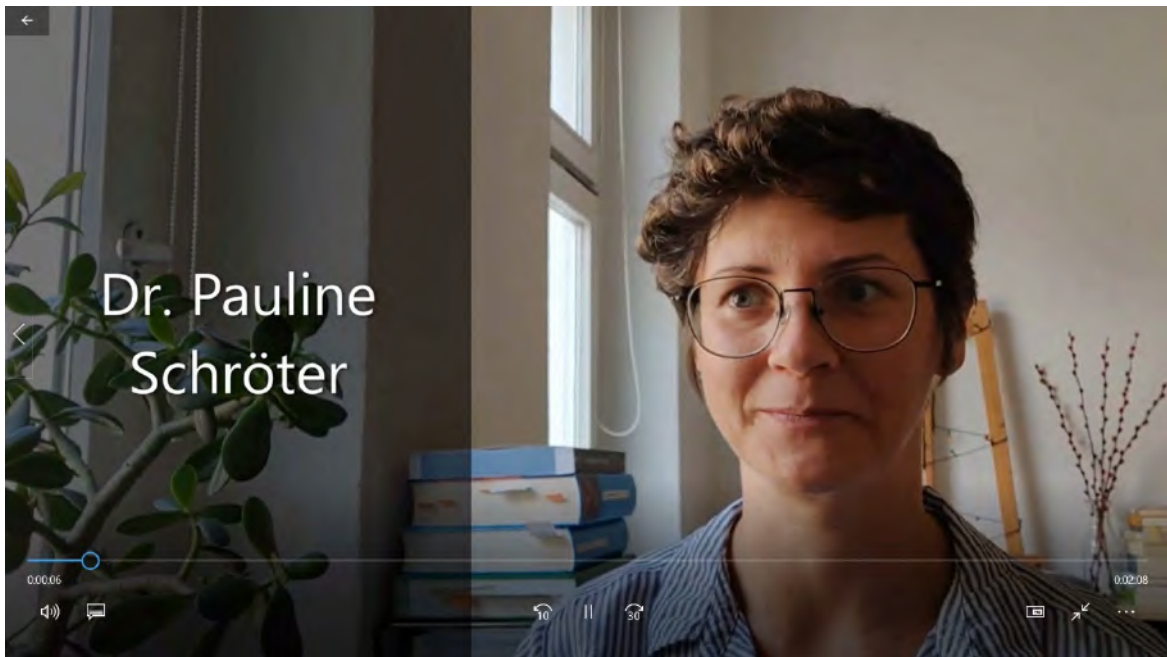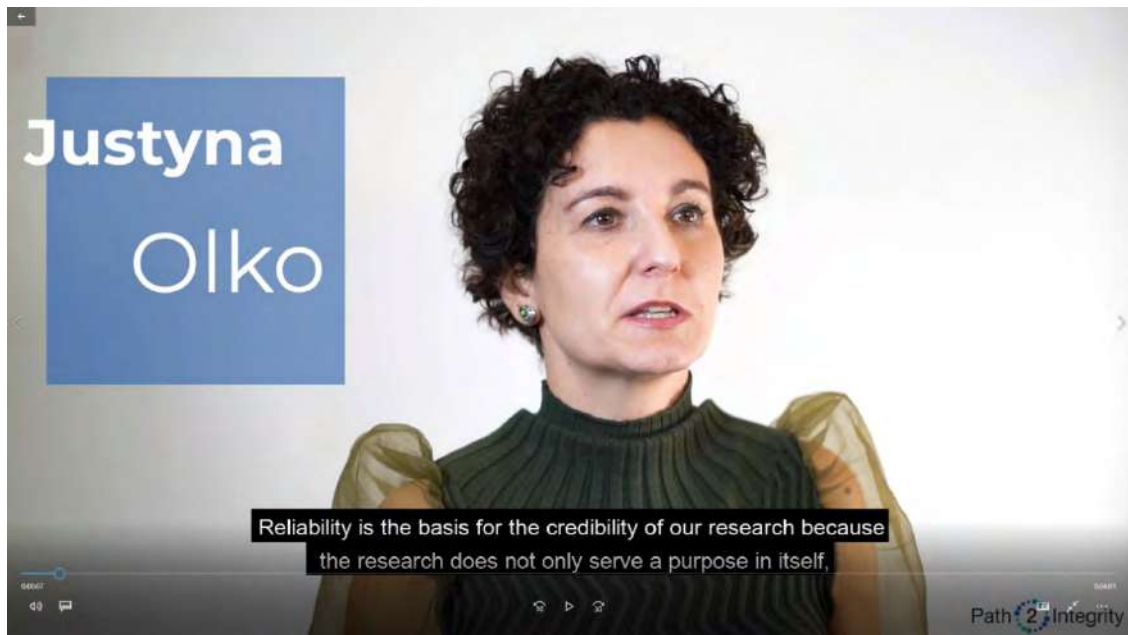
SPAIN

Dr. Fernández-Vidal

https://youtu.be/jam1axRcNPE

Dr. Rea (Italian nationality, working in Spain)

https://youtu.be/Ue3cwDFjDW8

Dr. Sánchez

https://youtu.be/HdcSpxBxu-c

Dr. Veiga

https://youtu.be/fyMy9hcB0XA