Learning Research Integrity at School

The path towards honest research works

Path 2 Integrity

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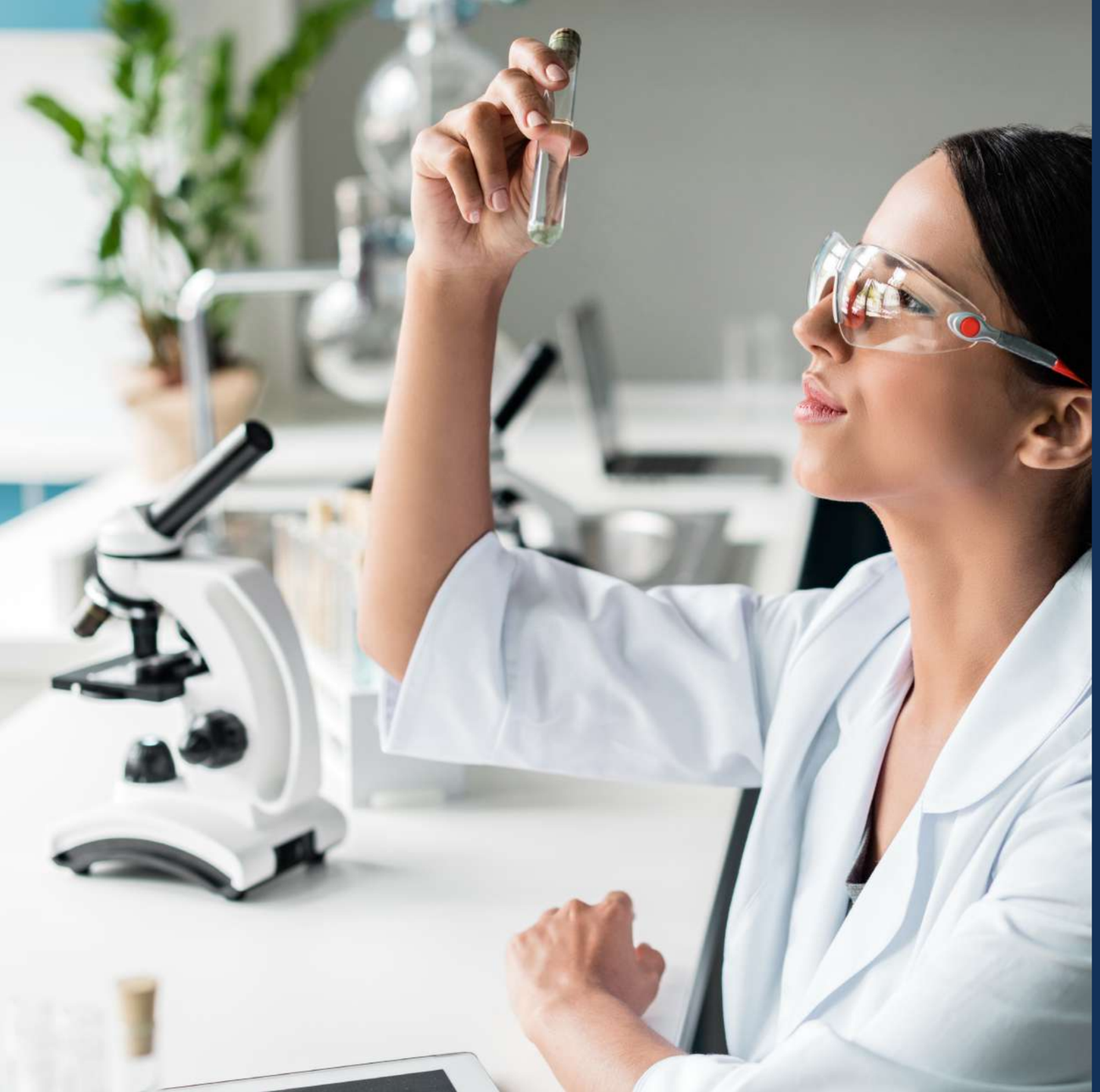

Content

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

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