TRAINING MATERIALS
for Responsible Open Science
Part III: Natural Sciences

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Training Materials for Responsible Open Science

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Introduction

The aim of the ROSiE Training Materials for Responsible Open Science is to learn how to practice open science (OS) responsibly and how to prevent research misconduct in the context of OS by providing necessary knowledge and developing specific skills and attitudes.

In the ROSiE Didactic Framework we have identified the following skills and attitudes necessary for responsible practising of OS in four domains: (i) local and global citizenship, (ii) personal and social responsibility, (iii) epistemic skills, and (iv) collaborative problem-solving.

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To achieve optimal results, the ROSiE training materials rely on several learning and teaching strategies: (i) collaborative problem solving; (ii) case-based activities; (iii) dialogical activities; (iv) transformative learning. More information about these teaching strategies you can find in the ROSiE Didactic Framework.

The training material consists of a trainers' file including 8 units and respective activities, as well as a separate folder including materials for trainees – required readings, handouts and printouts. The activities can be implemented separately (e.g., for organising a single workshop to discuss cases) or for organising a complete two-day training course. The suggested schedule for the training course is as follows:

Time	**DAY 1**	**Type of activity**
90 min.	Unit 1. Ethical and societal foundations of OS, its purpose	Home readings and Socratic seminar
15 min.	Break	
90 min.	Unit 2. Open science and data privacy in natural sciences	Case discussion
60 min.	Lunch break	
90 min.	Unit 3. Ethical aspects of citizen science in the context of OS	Home readings and group project **OR** Case discussion
15 min.	Break	
90 min.	Unit 4. Protection of intellectual property in the context of OS	Case discussion
Time	**DAY 2**	**Type of activity**
90 min.	Unit 5. The quality of the research outputs and data sets	Home readings and case discussion **OR** Case discussion
15 min.	Break	
90 min.	Unit 6. Responsible sharing and reuse of open natural science data	Brainstorming and group work **OR** Case discussion
60 min.	Lunch break	
90 min.	Unit 7. Prevention of research misconduct in the context of OS	Group work and plenary activity **OR** Case discussion
15 min.	Break	
90 min.	Unit 8. Responsible dissemination and publication practices	Case discussion

Additionally, trainers can use the ROSiE online training course as a complementary resource to this training material. Students and researchers can use ROSiE online

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learning modules to implement **self-directed learning**. In this case, the trainee as a user of online ROSiE training materials takes the initiative, with or without the help of the trainer, determines his/her learning needs, formulates learning goals and evaluates learning outcomes. In this process, trainees are in charge of their learning, and they are autonomous in choosing what, how and where they are learning. Online training materials can also be used for the implementation of **blended learning**, which combines traditional on-site training led by a trainer with using online content to allow trainees to build their own learning experience. By blending face-to-face and online training methods, trainees can benefit from guidance and interaction with a trainer while having access to interactive and flexible training opportunities outside the classroom. Blended learning allows development of **multimodal learning** through visual, auditory, reading, discussion and writing methods. Multimodal learning expands inclusive learning opportunities.

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Unit 1. Ethical and societal foundations of OS, its purpose

Activity 1. Principles, values and benefits of OS

DESCRIPTION

This activity starts with homework where trainees are asked to read UNESCO Recommendation on Open Science and fill in the double-entry reading journal. The purpose of the reading journal is to allow trainees to express their thoughts and reflect on the text. It is followed by classroom discussion in a form of Socratic seminar on principles and values of OS, as well as the main benefits and challenges in OS implementation.

Type of activity: home reading and Socratic seminar

Time: 90 min.

Target groups: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Ethical and societal foundations of open science

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– demonstrate knowledge of ethical foundations of OS	– explain and discuss principles and values of OS, its ethical foundations, and social benefits
	– understand the significance of OS and citizen science for identifying and solving scientific problems and societal challenges	– provide examples for role of OS and citizen science in identifying and solving scientific problems and societal challenges

PROCEDURE

1. At least a week before the workshop send trainees the required readings UNESCO Recommendation on Open Science and the handout (file "NS_U1A1 Handout").
2. Before the workshop trainees are required to read the parts I., II. and III. of the UNESCO Recommendation on Open Science (pp. 6-19).

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3. Before the workshop trainees should fill in the double-entry reading journal table in the handout. The left side should contain quotations from the UNESCO Recommendation on Open Science with page numbers noted. The right side should contain trainee's response to each quotation (a question, commentary, analysis). When filling in the table, trainees may use the following prompts, included in the handout:
    - *I agree/disagree with..., because...*
    - *It is not clear for me...*
    - *I see the following challenges...*
    - *I have a question regarding...*
4. The classroom discussion is organized as a Socratic seminar. The aim of the Socratic seminar is to achieve "*a deeper understanding about the ideas and values in a particular text*"[1]. The trainer is facilitator of the discussion, the discussion is led by using open-ended, high-level questions. Trainees are sitting in a circle.
5. The Socratic Seminar starts with introduction of the rules:
    - Only those trainees who have read the text and filled in the double-entry reading journal are allowed to participate;
    - It is important to focus on the text and to refer to evidence from the text;
    - Trainees are encouraged to talk to each other, not just to the trainer and to listen and respond to others' arguments.
6. Common questions used during a Socratic Seminar activity both by trainer and trainees include:
    - *What does this concept/idea/phrase etc. mean?*
    - *What do you think the authors are trying to say?*
    - *Is this what you mean to say...?*
    - *What is the origin of this?*
    - *What are the implications of this?*
    - *What else could that mean?*
    - *What would happen if....?*
7. This overview of Socratic seminar provides a list of suitable questions and more information about how to prepare for a discussion.

[1] Castellanos-Reyes, D. (2020). Socratic Seminar. In R. Kimmons & S. Caskurlu (Eds.), *The Students' Guide to Learning Design and Research*. EdTech Books. https://edtechbooks.org/studentguide/socratic_seminar

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PLANNING

Resources and equipment:

- Handout "NS_U1A1 Handout"
- Required readings UNESCO Recommendation on Open Science
- Make space for the trainees to sit in a circle

FURTHER READINGS

1. Allen, C., & Mehler, D. M. A. (2019). Open science challenges, benefits and tips in early career and beyond. *PLOS Biology*, 17(5), e3000246. https://doi.org/10.1371/journal.pbio.3000246
2. Castellanos-Reyes, D. (2020). Socratic Seminar. In R. Kimmons & S. Caskurlu (Eds.), *The Students' Guide to Learning Design and Research*. EdTech Books. https://edtechbooks.org/studentguide/socratic_seminar
3. Düwell, M. (2019). Open science and ethics. *Ethical Theory and Moral Practice*, 22(5), 1051-1053. https://doi.org/10.1007/s10677-019-10053-3
   Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. (2016). The academic, economic and societal impacts of Open Access: an evidence-based review. *F1000Research*, 5. https://doi.org/10.12688/f1000research.8460.3

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Unit 2. Protection of persons, communities, animals, plants and ecosystems in OS

Activity 2. Risks to persons, communities, environment, animals, plants, and ecosystems

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups cases on ethical issues in gathering, open sharing and reuse of sensitive data in natural sciences. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Risks to the environment, animals, plants, and ecosystems & Protection of privacy of persons and communities

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– describe the risks to persons, communities, environment, plants, animals, and ecosystems in the context of OS	– discuss how to minimize risks to persons, communities, environment, plants, animals, and ecosystems when practicing OS
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

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PROCEDURE

1. Depending on the size of the group and background of the trainees choose how many cases to discuss during the workshop. There are three cases included in the file "NS_U2A2 Handout".
2. Introduce the activity, its aim and, briefly, the procedure.
3. Print out case description(s) and questions for discussion for each trainee (file "NS_U2A2 Handout").
4. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.
5. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.
6. **Step 2**: reports from small group discussions – **40 minutes**. Depending on the number of small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
7. **Step 3**: group discussion – **20 minutes**. The trainer moderates a reflective group discussion. The trainer writes the solutions suggested during the discussion on the whiteboard and summarises them. Sample questions for reflective discussion are, e.g.:
   - *Which types of data are potentially sensitive in natural sciences?*
   - *How might sharing these types of data violate the protection of plants, animals or ecosystems (or privacy and security of individuals or communities_?*
   - *Do you agree with the authors' statement in one of the cases that: "Natural scientists have little guidance to deal with privacy concerns for open science, which are inherent in socio-environmental research"?*
   - *What should the scientists do to ensure responsible handling of data in each of the cases? What support they do need?*

PLANNING

Resources and equipment:

- Handout "NS_U2A2 Handout"
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

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FURTHER READINGS

1. Blatt, A. J. (2015). The benefits and risks of volunteered geographic information. *Journal of Map & Geography Libraries*, *11*(1), 99-104. https://doi.org/10.1080/15420353.2015.1009609
2. Lennox, R. J., Harcourt, R., Bennett, J. R., Davies, A., Ford, A. T., Frey, R. M., ... & Cooke, S. J. (2020). A novel framework to protect animal data in a world of ecosurveillance. BioScience, 70(6), 468-476. https://doi.org/10.1093/biosci/biaa035
3. Richardson, D. B., Kwan, M. P., Alter, G., & McKendry, J. E. (2015). Replication of scientific research: addressing geoprivacy, confidentiality, and data sharing challenges in geospatial research. *Annals of GIS*, *21*(2), 101-110. https://doi.org/10.1080/19475683.2015.1027792
4. Zipper, S. C., Stack Whitney, K., Deines, J. M., Befus, K. M., Bhatia, U., Albers, S. J., ... & Schlager, E. (2019). Balancing open science and data privacy in the water sciences. *Water Resources Research*, *55*(7), 5202-5211. https://doi.org/10.1029/2019WR025080

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Unit 3. Ethical aspects of citizen science in the context of OS

Activity 3. Development of an ethically sound citizen science project

DESCRIPTION

This activity involves home reading before the classroom activity, to introduce the concept of citizen science in the context of natural sciences. It is followed by group project onsite where trainees are asked to develop their own citizen science projects and analyse ethical aspects of these projects.

Type of activity: home reading and group project

Time: 90 min.

Target group: students, early career researchers, senior researchers

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– understand the significance of citizen science for identifying and solving scientific problems and societal challenges	– provide examples for role of citizen science in identifying and solving scientific problems and societal challenges

PROCEDURE

1. At least a week before the workshop send trainees the required readings: Stratilová Urválková & Janoušková (2019)[2].
2. During the workshop, introduce the group activity, its aim and, briefly, the procedure.
3. Ask trainees to split in three groups. The group task is to develop an idea for a citizen science project in natural sciences, by using definitions and examples

[2] Stratilová Urválková, E. S., & Janoušková, S. (2019). Citizen science–bridging the gap between scientists and amateurs. *Chemistry Teacher International*, *1*(2). https://doi.org/10.1515/cti-2018-0032

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provided in the required readings. For taking notes print one copy of "NS_U3A3 Handout" for each group.

4. **Step 1** development of the project idea – **30 minutes**. Each group should discuss and fill in the table 1 in the "NS_U3A3 Handout".
5. **Step 2** reflection on ethical aspects of the project – **30 minutes**. Each group should discuss and fill in the table 2 in the "NS_U3A3 Handout".
6. **Step 3** presentation of group projects and general discussion – **30 minutes**. Sample questions for reflective discussion are, e.g.:
   - *What does citizen science add to the field of natural sciences?*
   - *What are the main ethical challenges and their solutions in citizen science projects in natural sciences?*

PLANNING

Resources and equipment:

- Readings: Stratilová Urválková & Janoušková (2019)
- Handout "NS_U3A3 Handout"
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Balázs, B., Mooney, P., Nováková, E., Bastin, L., Jokar Arsanjani, J. (2021). Data Quality in Citizen Science. In: *The Science of Citizen Science*. Springer https://doi.org/10.1007/978-3-030-58278-4_8
2. Frigerio, D., Richter, A., Per, E., Pruse, B., & Vohland, K. (2021). Citizen science in the natural sciences. In: *The Science of Citizen Science*. Springer. https://doi.org/10.1007/978-3-030-58278-4_5

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Activity 3.1. Authorship and contributorship in citizen science

DESCRIPTION

This activity is built around case discussion and involves evaluating pro and contra arguments for different types of acknowledging citizen scientist contributions to research. Trainees are asked to discuss the case in small groups, develop and discuss their arguments. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Ethical aspects of citizen science

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware of citizen scientists' right to be recognised and acknowledged by academic scientists and society	– discuss and assert their right to be recognized and acknowledged by academic scientists and society
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Introduce the activity, its aim and, briefly, the procedure.
2. Ask trainees to split in small groups (3-4 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group.
3. Print out the case description and questions for discussion for each trainee (file "NS_U3A3.1_Handout". You can also choose to watch the case in the classroom - **animation of this case is available on the ROSiE Knowledge Hub.**

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4. **Step 1**: small group discussions – **30 minutes**. Trainees read or watch the case and discuss the questions in small groups. Each group fills in the table included in the handout with pro and contra arguments. Rapporteurs prepare to present the results to the whole group.
5. **Step 2**: short reports from small group discussions – **20 minutes**. Rapporteurs present the results of their group discussions - pro and contra arguments for each type of acknowledging the contribution of citizen scientists in this case.
6. **Step 3**: group discussion – **40 minutes**. The trainer moderates a reflective group discussion. Sample questions for reflective discussion are, e.g.:
   - *Based on the pro and contra arguments developed during the group work, what is the best solution for this case?*
   - *Do you have other suggestions for recognizing the contribution of citizen scientists in scientific publications*

PLANNING

Resources and equipment:

- Handout "NS_U3A3.1 Handout" and/or video of case animation available on the ROSiE Knowledge Hub
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. COPE Council (2003). How to Handle Authorship Disputes: A Guide for New Researchers. https://doi.org/10.24318/cope.2018.1.1
2. ICMJE. Defining the role of authors and contributors. https://bit.ly/N7uoq3
3. Smith, E., Bélisle-Pipon, J. C., & Resnik, D. (2019). Patients as research partners; how to value their perceptions, contribution and labor? *Citizen science: theory and practice*, *4*(1). https://doi.org/10.5334/cstp.184
4. The Embassy of Good Science: "Authorship criteria"
5. Vasilevsky, N. A. et al. (2021). Is authorship sufficient for today's collaborative research? A call for contributor roles. *Accountability in Research*, *28*(1), 23-43. https://doi.org/10.1080/08989621.2020.1779591

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Unit 4. Protection of intellectual property in the context of OS

Activity 4. Should scientists use access to pirated papers?

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups a case on violations of intellectual property rights by providing access to pirated scientific publications. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 minutes

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Protection of intellectual property in the context of open science

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware of protection of intellectual property in OS	– recognizing limits of open science for the protection of data and intellectual property rights
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Print out the case description and questions for discussion for each trainee (file "NS_U4A4_Handout". You can also choose to watch the case in the classroom - **animation of this case is available on the ROSiE Knowledge Hub.**
2. Introduce the activity, its aim and, briefly, the procedure.

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3. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.
4. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.
5. **Step 2**: reports from small group discussions – **30 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
6. **Step 3**: group discussion – **30 minutes**. The trainer moderates a reflective group discussion. The trainer writes the ideas suggested during the discussion on the whiteboard and summarises them. Sample questions for reflective discussion are, e.g.:

- *How important are intellectual property rights for scientific research and achievements?*
- *Does the case address a relevant issue for you and researchers you are working together?*
- *What are potential solutions at the policy level to the problem described in the case?*

PLANNING

Resources and equipment:

- Handout "NS_U4A4 Handout" and/or video of case animation available on the ROSiE Knowledge Hub
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Bender, M. 'It's a Moral Imperative:' Archivists made a directory of 5000 Coronavirus studies to bypass paywalls. *Vice,* February 3, 2020. https://www.vice.com/en/article/z3b3v5/archivists-are-bypassing-paywalls-to-share-studies-about-coronaviruses
2. Monbiot, G. Scientific publishing is a rip-off. We fund the research - it should be free. *The Guardian.* September 13, 2018. https://www.theguardian.com/commentisfree/2018/sep/13/scientific-publishing-rip-off-taxpayers-fund-research.

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3. Plan S (2018). Open Access is Foundational to the Scientific Enterprise. https://www.coalition-s.org/why-plan-s/
4. Van Noorden, R. (2016). Alexandra Elbakyan: Paper pirate. *Nature,* 540, 512. https://doi.org/10.1038/540507a
5. Vogel, G., & Kupferschmidt, K. (2017). A bold open-access push in Germany could change the future of academic publishing. *Science*, *23*. https://doi.org/10.1126/science.aap7562

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Activity 4.1. Protection of intellectual property in the context of open science

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups a case on protection of intellectual property in natural sciences leading to retraction of a paper due to noncompliance with the journal's data policy. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Protection of intellectual property in the context of open science

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware of protection of intellectual property in OS	– recognizing limits of open science for the protection of data and intellectual property rights
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Print out the case description and questions for discussion for each trainee (file "NS_U4A4.1 Handout". You can also choose to watch the case in the classroom - **animation of this case is available on the ROSiE Knowledge Hub.**
2. Introduce the activity, its aim and, briefly, the procedure.
3. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.

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4. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.
5. **Step 2**: reports from small group discussions – **30 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
6. **Step 3**: group discussion – **30 minutes**. The trainer moderates a reflective group discussion. The trainer writes the solutions suggested during the discussion on the whiteboard and summarises them. Sample questions for reflective discussion are, e.g.:
   - *Are commercial interests and protection of intellectual property legitimate arguments not to share raw data?*
   - *Why might scientists have reservations about sharing their data?*

PLANNING

Resources and equipment:

- Handout "NS_U4A4.1 Handout" and/or video of case animation available on the ROSiE Knowledge Hub
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Editorial (2018). Data sharing and the future of science. *Nature Communications*, *9*, 2817-2817. https://doi.org/10.1038/s41467-018-05227-z
2. Staunton, C., Barragán, C. A., Canali, S., Ho, C., Leonelli, S., Mayernik, M., ... & Wonkham, A. (2021). Open science, data sharing and solidarity: who benefits? *History and Philosophy of the Life Sciences*, 43(4), 1-8. https://doi.org/10.1007/s40656-021-00468-6

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Unit 5. The quality of the research outputs and data sets

Activity 5. Responsibility for the quality of research data

DESCRIPTION

This activity starts with homework where trainees are asked to read a paper on data quality in citizen science and create a mind map. The purpose of the mind map is to build a background knowledge for case discussion. It is followed by case discussion and development of guidelines for ensuring quality of citizen sciences data in natural sciences.

Type of activity: home readings and case discussion

Time: 90 min.

Target group: students, early career researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Quality of research outputs and data sets

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware of importance of the quality of data sets and research outputs in OS and their responsible use	– explain how to responsibly prepare, assess, and use open data sets and research outputs
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. At least a week before the workshop send trainees the required readings Balázs et al. (2021)[3] and the handout for creating a mind map (file "NS_U5A5_1

[3] Balázs, B., Mooney, P., Nováková, E., Bastin, L., Jokar Arsanjani, J. (2021). Data Quality in Citizen Science. In: The Science of Citizen Science. Springer https://doi.org/10.1007/978-3-030-58278-4_8.

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Handout"). Before the workshop trainees are required to read the required readings.

2. Before the workshop trainees should create a mind map on quality of data in citizen science, based on the required readings. Instructions for creating a mind map are included in the handout "NS_U5A5_1 Handout".
3. In the classroom, introduce the activity, its aim and, briefly, the procedure.
4. Ask trainees to split in small groups (4-6 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group.
5. Print out the case description (file "NS_U5A5_2 Handout") for each trainee
6. **Step 1**: small group discussions – **40 minutes**. Trainees read the case description, discuss the challenges, use the ideas from required readings and develop recommendations. Each group fills in a table with challenges and recommendations. The table is included in the "NS_U5A5_2 Handout". Rapporteurs prepare to present the results to the whole group.
7. **Step 2**: reports from small group discussions – **30 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 3 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
8. **Step 3**: group discussion – **20 minutes**. The trainer moderates a reflective group discussion. Sample questions for reflective discussion are, e.g.:
   - *Which ideas from the required readings helped you to develop recommendations? How?*
   - *Which of the recommendations developed during the groupwork are the most useful? Why?*
   - *In your view, what are other considerable ethical challenges for scientists collaborating with citizen scientists? How to address these challenges?*

PLANNING

Resources and equipment:

- Required readings Balázs et al. (2021)
- Handout "NS_U5A5_1 Handout" for home reading and creating a mind map
- Handout "NS_U5A5_2 Handout" for case discussion
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

This project has received funding from the European Union's Horizon 2020 research and innovation programme under GA No 101006430

FURTHER READINGS

1. Haklay, M. (2021). Why is it so difficult to integrate citizen science into practice? *Citizen Science and Public Policy Making*, 108. https://discovery.ucl.ac.uk/id/eprint/10130136
2. Herodotou, C., Scanlon, E., & Sharples, M. (2021). Methods of promoting learning and data quality in citizen and community Science. *Frontiers in Climate*, 53. https://doi.org/10.3389/fclim.2021.614567

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Activity 5.1. Conflicts of interest in citizen science

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups a case on risk conflicts of interest in citizen science. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Quality of research outputs and data sets

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– understand the concept of conflict of interest and how to deal with it	– recognize and disclose conflicts of interest in cases when citizen scientists have personal or political interests at stake
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

7. Print out the case description and questions for discussion for each trainee (file "NS_U5A5.1 Handout". You can also choose to watch the case in the classroom - **animation of this case is available on the ROSiE Knowledge Hub.**
8. Introduce the activity, its aim and, briefly, the procedure.
9. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.
10. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.

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11. **Step 2**: reports from small group discussions – **30 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
12. **Step 3**: group discussion – **30 minutes**. The trainer moderates a reflective group discussion. The trainer writes the solutions suggested during the discussion on the whiteboard and summarises them. Sample questions for reflective discussion are, e.g.:

    - *What is your personal experience with conflicts of interest in research?*
    - *What types of conflicts of interest should be disclosed? Is there a consensus on that in your field of science?*
    - *Do conflicts of interest in citizen science differ from conflicts of interest in science in general? If yes, what is the difference?*
    - *How to deal with conflicts of interest in cases where they are discovered after the publication of a research study?*

PLANNING

Resources and equipment:

- Handout "NS_U5A5.1 Handout" and/or video of case animation available on the ROSiE Knowledge Hub
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. COPE Council (2021). COPE Flowcharts and infographics: Undisclosed conflict of interest in a published article. https://doi.org/10.24318/cope.2019.2.7
2. Macey, G. P., Breech, R., Chernaik, M., Cox, C., Larson, D., Thomas, D., & Carpenter, D. O. (2014). Air concentrations of volatile compounds near oil and gas production: a community-based exploratory study. *Environmental Health*, *13*(1), 1-18. https://doi.org/10.1186/1476-069X-13-82
3. Resnik, D. B., Konecny, B., & Kissling, G. E. (2017). Conflict of interest and funding disclosure policies of environmental, occupational, and public health journals. *Journal of occupational and environmental medicine*, *59*(1), 28. https://doi.org/10.1097/JOM.0000000000000910
4. The Embassy of Good Science: "Conflict of interests", "Intellectual conflicts of interest"

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Unit 6. Responsible sharing and reuse of natural science data

Activity 6. Concerns to share and reuse data

DESCRIPTION

This activity starts with brainstorming where trainees are asked to share their views on sharing and reusing research data. It is followed by group discussion on concerns to share and reuse data, as well as possible solutions.

Type of activity: brainstorming and group discussion

Time: 90 min.

Target group: students, early career researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Responsible sharing and reuse of data and other research outputs

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware about factors influencing willingness to share and use open research data	– discuss how to increase willingness to share and use open research data

PROCEDURE

1. **Step 1:** brainstorming – **15 minutes**. The trainer starts brainstorming by posing two questions: (1) "*Are you ready to share your research data in an open data repository? Why yes or no?*" and (2) "*Are you ready to use open access data in your research? Why yes or no*?" and invite trainees to take a minute's silence to think on it. Once the minute is up, invite everyone to share their views. Have a single person (trainer or one of trainees) who takes notes on a whiteboard. The main aim of brainstorming is just to listen to different views without criticism.
2. Ask trainees to split in small groups (4-6 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group.

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3. Distribute the handout (file "NS_U6A6_Handout") to each group. Half of the groups receive Task 1 from the handout ("Sharing your own research data"), other groups get Task 2 from the handout ("Using open data created by other researchers").
4. **Step 2**: small group discussions – **30 minutes**. Trainees discuss and fill in a table with concerns and possible solutions. Rapporteurs prepare to present the results to the whole group.
5. **Step 3**: reports from small group discussions – **30 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 3 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
6. **Step 3**: group discussion – **15 minutes**. The trainer moderates a reflective group discussion. Sample questions for reflective discussion are, e.g.:
   - *What are the most important concerns discouraging researchers to share their data for reuse and to use open data created by other researchers? What are possible solutions?*
   - *Are there any legitimate reasons not to share research data?*
   - *How to responsibly share and reuse data in natural sciences?*

PLANNING

Resources and equipment:

- Handout "Handout NS_U6A6" printed out for each small group
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Data sharing and the future of science. *Nature Communications* 9, 2817 (2018). https://doi.org/10.1038/s41467-018-05227-z
2. McAllister, J. W. (2012). Climate science controversies and the demand for access to empirical data. *Philosophy of Science*, 79(5), 871-880. https://doi.org/10.1086/667871
3. Zuiderwijk, A., Shinde, R., & Jeng, W. (2020). What drives and inhibits researchers to share and use open research data? A systematic literature review to analyze factors influencing open research data adoption. *PloS one*, *15*(9), e0239283. https://doi.org/10.1371/journal.pone.0239283

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Activity 6.1. Case discussion on concerns about sharing the data

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups cases on scientists' concerns to share the data. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Responsible sharing and reuse of data and other research outputs

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware about factors influencing willingness to share and use open research data	– discuss how to increase willingness to share and use open research data
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Depending on the size of the group and background of the trainees choose how many cases to discuss during the workshop. There are three cases included in the file "NS_U6A6.1 Handout". You can also choose to watch one of the cases in the classroom - **animations of cases are available on the ROSiE Knowledge Hub.**
2. Introduce the activity, its aim and, briefly, the procedure.
3. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.

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4. Print out case description(s) and questions for discussion for each trainee (file "NS_U6A6.1 Handout".
5. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.
6. **Step 2**: reports from small group discussions – **40 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group have 10 minutes for a presentation). Rapporteurs present the results of their group discussions.
7. **Step 3**: group discussion – **20 minutes**. The trainer moderates a reflective group discussion. The trainer writes the solutions suggested during the discussion on the whiteboard and summarises them. Sample questions for reflective discussion are, e.g.:
   - *What are the most important concerns discouraging researchers to share their data for reuse and to use open data created by other researchers? What are possible solutions?*
   - *Are there any legitimate reasons not to share research data?*
   - *How to responsibly share and reuse data in natural sciences?*

PLANNING

Resources and equipment:

- Handout "NS_U6A6.1 Handout" and/or animations of cases available on the ROSiE Knowledge Hub
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Availability of Data. Nature portfolio. https://www.nature.com/nature-portfolio/editorial-policies/reporting-standards#availability-of-data
2. Data sharing and the future of science. *Nat Commun* 9, 2817 (2018). https://doi.org/10.1038/s41467-018-05227-z
3. Gewin, V. (2016.) Data sharing: An open mind on open data. *Nature* 529. https://doi.org/10.1038/nj7584-117a
4. Laine, H. (2017). Afraid of scooping: Case study on researcher strategies against fear of scooping in the context of open science. *Data Science Journal*. https://doi.org/10.5334/dsj-2017-029

This project has received funding from the European Union's Horizon 2020 research and innovation programme under GA No 101006430

5. Zuiderwijk, A., Shinde, R., & Jeng, W. (2020). What drives and inhibits researchers to share and use open research data? A systematic literature review to analyze factors influencing open research data adoption. *PloS one*, *15*(9), e0239283. https://doi.org/10.1371/journal.pone.0239283

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Unit 7. Prevention of research misconduct in the context of OS

Activity 7. Violations of research integrity in OS and their prevention

The activity aims to discuss different types of violations of research integrity in OS and their prevention. The trainees are split into five groups and their task is to reflect on potential type of violation and preventive measure in each OS activity. Each group shares the results of their discussions, and group work is followed by plenary activity where all trainees have an opportunity to supplement the results of group work.

Type of activity: group work and plenary activity

Time: 90 minutes

Target group: students, early career researchers, senior researchers

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– know potential types of research misconduct in OS	– discuss causes of violations of research integrity in OS and ways of its prevention

PROCEDURE

1. Before the exercise, print out the pages with different types of open science activities (file "NS_U7A7 Printout") and mark sections of a wall with the titles:
   - *Open access publishing*
   - *Sharing and using open data*
   - *Open reproducible research, e.g., open lab notes, reproducing of research studies*
   - *Open science evaluation, e.g., open metrics and impact, open peer review*
   - *Citizen science*
2. Ask participants to split in five groups. Assign one of the types of open science activities listed above to each group.
3. **Step 1:** group discussion – **25 minutes**. Each group discusses the following questions in the context of the particular type of open science activities:

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- *What potential violations of research integrity may arise in the context of this type of open science activities?*
- *How to prevent these potential violations?*

The results of the discussion should be written on paper cards/sticky notes – one potential type of violation and preventive measure on each card/sticky note and hung on the wall under the respective type of open science activities.

4. **Step 2**: group work presentations and general discussion – **65 minutes**. Each group presents their results in 5 minutes. After each presentation, there is 8 minutes general discussion where every trainee has an opportunity to suggest additional challenges and preventive measures. These additional challenges and preventive measures are written on paper cards/sticky notes and added to the respective type of open science activities.

PLANNING

Resources and equipment:

- Printout "NS_U7A7 Printout"
- Large wall or multiple pinboards to hang on printouts and results of discussions
- Empty cards & tape/sticky notes, pens/markers
- Make space for the trainees to work in small groups and to move around

FURTHER READINGS

1. Düwell, M. (2019). Open science and ethics. *Ethical Theory and Moral Practice*, 22, 1051-1053. https://doi.org/10.1007/s10677-019-10053-3

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Activity 7.1. Inequities and potential of exploitation in OS

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups a case on ethical issues on inequities and potential of exploitation in OS in natural sciences, especially in the context of low- and middle- income countries. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Prevention of research misconduct in open science

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– know potential types of research misconduct in OS	– discuss causes of violations of research integrity in OS and ways of its prevention
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Introduce the activity, its aim and, briefly, the procedure.
2. Ask trainees to split in small groups (3-4 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group.
3. Print out the case description and questions for discussion for each trainee (file "NS_U7A7.1 Handout".
4. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Rapporteurs prepare to present the results to the whole group.

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5. **Step 2**: short reports from small group discussions – **30 minutes**. Rapporteurs present the results of their group discussions.
6. **Step 3**: group discussion – **30 minutes**. The trainer moderates a reflective group discussion. Sample questions for reflective discussion are, e.g.:
   - *Based on the arguments developed during the group work, what are the best approaches for reducing risk of exploitation in the context of open science?*
   - *What are the best practices for protection of intellectual property when practician open science?*

PLANNING

Resources and equipment:

- Handout "NS_U7A7.1 Handout"
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Ross-Hellauer, T., Reichmann, S., Cole, N. L., Fessl, A., Klebel, T., & Pontika, N. (2022). Dynamics of cumulative advantage and threats to equity in open science: a scoping review. *Royal Society Open Science*, 9(1), 211032. https://doi.org/10.1098/rsos.211032
2. Zeitlyn, D. (2003). Gift economies in the development of open source software: anthropological reflections. *Research Policy*, 32(7), 1287-1291. https://doi.org/10.1016/S0048-7333(03)00053-2

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Unit 8. Responsible dissemination and publication practices

Activity 8. Open access publishing and predatory practices

DESCRIPTION

This activity applies the Four Quadrant Method for case analysis on predatory practices. Trainees are asked to discuss a case in small groups and fill in the Four Quadrant template. Afterwards, small groups report to the whole group and continue with a casuistic reasoning and justification discussion involving the whole group.

Type of activity: case discussion (Four Quadrant Method)

Time: 90 min.

Target group: students, early career researchers, senior researchers

Blended learning options: ROSiE online training course → Responsible Open Science → Natural Sciences → Responsible dissemination and publication practices

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– know criteria for good practice standards in open access publishing	– critically assess scientific results published in open access and identify predatory publishing practices
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Introduce the activity, its aim and, briefly, the procedure of the Four Quadrant Method[4].

[4] Detailed description of the modified Four Quadrant Method for case analysis is provided by the EnTIRE project: Armond A.C. et al. (2019). D.5.3 Delivery of the entire set of case deliberation methods and case analyses as input for the platform, pp. 98-102.

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2. Print out the case description (file "NS_U8A8 Handout") for each trainee.
3. Ask trainees to split in small groups (3-4 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group.
4. **Step 1.** Initial perception – **20 minutes**. Trainees read the case and in small groups discuss some general questions to identify relevant aspects of the case:
   - *What are the ethical issues at stake in this case?*
   - *Who are the stakeholders?*
   - *How should stakeholders react to this case?*
   - *What should/can stakeholders do to prevent such cases?*
5. **Step 2.** The Four Quadrant Analysis – **20 minutes**. Each group fills in the four quadrant table included in the file "NS_U8A8 Handout".

I. Relevant Facts: What are the most relevant facts concerning the situation?	**II. Uncertainties**: Which features of the situation are uncertain, lacking in clarity, or controversial?
III. **Courses of Action**: What are the practically available options for providing a solution to the case (how to react to the case and how to prevent such cases in the future)?	IV. **Contextual Features**: What legal, financial and institutional policies and regulations apply to the case?

6. **Step 3.** Reports from small groups – **20 minutes**. The small groups report the results of the Four Quadrant Analysis to the whole group.
7. **Step 4.** Casuistic Reasoning and Justification – **30 minutes**. The trainer moderates the whole group discussion on the following questions:
   - *What is at issue? What is the major ethical issue at the case?*
   - *Do you know other cases like this one?*
   - *Why do academics publish their research in a predatory journal or books published by predatory publishers? What are the main factors that motivate such a practice? What are negative consequences of such a practice? What policies might minimise predatory publishing practices?*
   - *How should stakeholders react to cases like this?*

PLANNING

Resources and equipment:

- Handout "NS_U8A8 Handout"

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- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Bartholomew, R. E. (2014). Science for sale: The rise of predatory journals. *Journal of the Royal Society of Medicine*, 107(10), 384–385. https://doi.org/10.1177/0141076814548526
2. Beall, J. (2015). Criteria for determining predatory open access publishers. https://beallslist.net/wp-content/uploads/2019/12/criteria-2015.pdf
3. Kurt, S. (2018). Why do authors publish in predatory journals? *Learned Publishing*, *31*(2), 141-147. https://doi.org/10.1002/leap.1150
4. The Embassy of Good Science: "Predatory publishing"

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Activity 8.1. Open peer review

DESCRIPTION

This activity is built around case discussion. Trainees are asked to discuss in small groups a case on open peer review. Afterwards, small groups report to the whole group and continue with a reflective discussion involving the whole group.

Type of activity: case discussion

Time: 90 min.

Target group: early career researchers, senior researchers

Learning outcomes:

	Learning outcomes *It is expected that trainees will:*	**Indicators for their achievement** *Trainees who have fully met the learning outcome are able to:*
	– be aware of importance of open peer review practices	– explain how to responsibly and critically perform open peer review
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS	– develop reflective questions to define ethical problems in the case study – discuss cases with colleagues – justify a personal position on the case

PROCEDURE

1. Introduce the activity, its aim and, briefly, the procedure.
2. Ask trainees to split in small groups (4-5 trainees in a group) and to choose a rapporteur - a group member who will report results of the small group discussion to the whole group. Provide each group with a paper for taking notes.
3. Print out case description and questions for discussion for each trainee (file "NS_U8A8.1 Handout").
4. **Step 1**: small group discussions – **30 minutes**. Trainees read the case description and discuss the questions in small groups. Each group takes notes. Rapporteurs prepare to present the results to the whole group.
5. **Step 2**: reports from small group discussions – **40 minutes**. Depending on the number of the small groups, allocate a time slot for each group presentation (e.g., if there are 4 small groups, each group has 10 minutes for a presentation). Rapporteurs present the results of their group discussions.

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6. **Step 3**: group discussion – **20 minutes**. The trainer moderates a reflective group discussion. The trainer writes the ideas suggested during the discussion on the whiteboard and summarise them. Sample questions for reflective discussion are, e.g.:
   - *What is the role of open peer review in the scientific publishing process?*
   - *What are the benefits and risks of open peer review?*

PLANNING

Resources and equipment:

- Handout "NS_U8A8.1 Handout"
- Paper for taking notes during small group discussions
- Whiteboard for discussion notes
- Make space for the trainees to work in small groups

FURTHER READINGS

1. Harms, P. D., & Credé, M. (2020). Bringing the review process into the 21st century: Post-publication peer review. *Industrial and Organizational Psychology*, *13*(1), 51-53. https://doi.org/10.1017/iop.2020.13
2. Ross-Hellauer, T., Deppe, A., & Schmidt, B. (2017). Survey on open peer review: Attitudes and experience amongst editors, authors and reviewers. PloS One, 12(12), e0189311. https://doi.org/10.1371/journal.pone.0189311
3. Tenorio-Fornés, Á., Tirador, E. P., Sánchez-Ruiz, A. A., & Hassan, S. (2021). Decentralizing science: Towards an interoperable open peer review ecosystem using blockchain. *Information Processing & Management*, *58*(6), 102724. https://doi.org/10.1016/j.ipm.2021.102724
4. The Embassy of Good Science: "Post-publication peer review"
5. The Embassy of Good Science: "Open peer review - transparent way of gatekeeping science"

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