D7.1: Didactic framework

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RESPONSIBLE OPEN SCIENCE IN EUROPE

ROSiE

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ABSTRACT:	The didactic framework serves as a base for developing ROSiE training materials with and for students, researchers, and citizen scientists for acquiring skills required for practicing responsible OS. The didactic framework identifies: (1) the skills and attitudes trainees are expected to acquire, (2) specific learning outcomes and indicators for their achievement, (3) topics to be included in training materials, (3) teaching and learning strategies.
Keyword List:	Ethics and integrity training, training materials, skills, learning objectives, teaching and learning methods

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3.	Partner	European Citizen Science Association	ECSA	Germany
4.	Partner	European Network of Research Ethics Committees	EUREC	Germany
5.	Partner	Federation of Finnish Learned Societies	TSV	Finland
6.	Partner	High Council for the Evaluation of Research and Higher Education	Hcéres	France
7.	Partner	National Research Institute for Agriculture, Food and Environment	INRAe	France
8.	Partner	National Technical University of Athens	NTUA	Greece
9.	Partner	Universidade Católica Portuguesa (UCP)	UCP	Portugal
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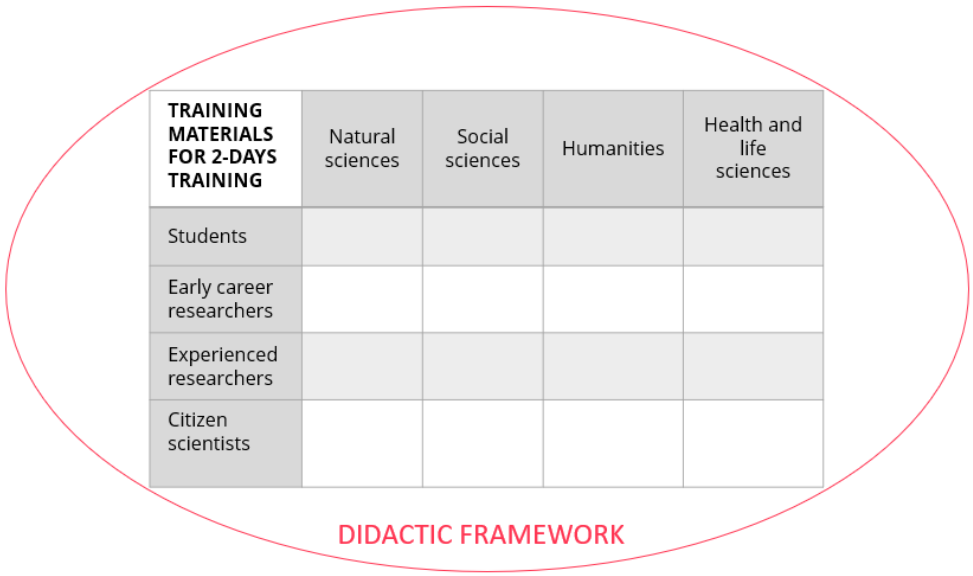
1 Background

ROSiE (https://rosie-project.eu/) is a three-year project funded by HORIZON 2020. Part of its mission is to develop novel practical tools co-created with all related stakeholders to foster responsible open science (OS) and citizen science. In line with this mission, one of the objectives of the ROSiE project is to develop training materials with and for students, researchers, and citizen scientists for acquiring skills required for practicing responsible OS. The training materials will cover the research ethics and integrity aspects of OS. To accomplish this objective, we have developed a didactic framework, identifying the following:

1) the skills and attitudes trainees are expected to acquire,
2) specific learning outcomes and indicators for their achievement,
3) topics to be covered by training materials,
4) teaching and learning strategies.

To fulfil this task, we used the results of the literature review and the mapping of ethical, social, and legal challenges of OS performed in the ROSiE project and consulted with stakeholder representatives. A consortium workshop for development of the didactic framework was organized in June 2021.

The ROSiE training materials will be aimed at the following groups of trainees: (i) students, (ii) early career researchers, (iii) experienced researchers and (iv) citizen scientists. For each group of trainees in each field of science - natural sciences, social sciences, humanities, health and life sciences – we will develop customized training materials for a 2-day training course.



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The developed training materials will be tested in various types of institutional and educational settings, e.g., universities, research centres, civil society organizations with a focus on OS. ROSiE consortium members will collaborate with stakeholders in designing and developing materials, piloting these materials, and revising and amending them based on the results of the pilot testing. The training materials will be complemented by a set of instructions supporting trainers in using the materials. Among other instructions, suggestions how the training materials might be used for training multidisciplinary and/or multistakeholder research teams will be included.

One of the main theoretical approaches we used for the development of the didactic framework is the 21st Century Skills approach (Griffin & Care, 2015a) which is aimed at developing personal and social responsibility, collaborative problem-solving skills, as well as local and global citizenship. The history of 21st Century Skills approach goes back to 2008 when employers and stakeholders raised concerns about the skills of new graduates and stated that they are equipped with "*skills that did not prepare them for employment in a digital age*" (Griffin & Care, 2015a). As a result, an international group of scholars was established to define the scope of 21st Century Skills, as well as to develop tools for assessment of these skills (Griffin & Care, 2015b). In parallel, we explored several didactic approaches to teaching research ethics and integrity (Pimple, 2007), lifelong learning and value teaching (Han, 2015; Kretz, 2014; Molewijk et al., 2008; Todd et al., 2017; van den Bemt et al., 2018), and their elements have been applied for the development of the didactic framework.

The ROSiE consortium aims at developing a didactic framework which is learner-centred, based on interests, backgrounds and learning styles of trainees, and ensure active and collaborative involvement in the learning process.

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2 Skills and attitudes for responsible practising of OS

Based on the 21st Centuries Skills approach (Griffin & Care, 2015a) and the literature analysis, 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.

Local and global citizenship

- awareness of the importance and social benefits of OS and citizen science in local and global contexts
- participation in ethics and integrity self-regulation of OS and citizen science community

Personal and social responsibility

- personal and professional responsibility for implementation of OS and production of results
- openess to share own research data, results , tools and publications and appreciation of efforts of others

Epistemic skills

- ability to organize, present and use open data and knowledge with integrity
- ability to critically assess data, knowledge and scientific results produced by others
- ability to identify ethical and integrity issues in OS

Collaborative problem-solving

- ability to apply critical thinking skills in collaborative analysis of ethical and integrity problems in OS
- discussing, finding solutions and making desicions to handle ethics and integrity issues within OS community

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3 Learning outcomes and indicators for their achievement

3.1 Students

	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 OS value, 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
	– recognize the importance and infrastructural challenges of low- and middle-income countries (LMIC) participation in OS	– discuss importance of solving inequities within the global OS ecosystem
	– know potential types of research malpractice in OS	– discuss causes of research malpractice in OS and ways of its prevention
	– describe the risks to data safety/security in the context of OS and be informed about tools for minimizing these risks	– provide examples of appropriate methods and tools for data protection in the context of OS
	– describe the risks to research participants, environment, plants, animals, and ecosystems in the context of OS	– discuss how to minimize risks to research participants, environment, plants, animals, and ecosystems when practicing OS
	– be aware of importance of the quality of data sets and research outputs in OS and their responsible use	– explain how to responsibly and critically assess and use open data and research outputs
	– 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

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3.2 Early career researchers

	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 significance of OS and citizen science for identifying and solving scientific problems and societal challenges	– explain and discuss the role of OS and citizen science in identifying and solving scientific problems and societal challenges
	– recognize the importance and infrastructural challenges of LMIC participation in OS	– discuss ways to solve inequities within the global OS ecosystem
	– know potential types of research malpractice in OS	– recognize research malpractice in OS, discuss its causes and ways of prevention
	– describe the risks to data safety/security in the context of OS and be informed about methods and tools for minimizing these risks	– choose and apply appropriate methods and tools for data protection in OS – develop an informed consent procedure and documents including ethical aspects of OS
	– describe the risks to research participants, environment, plants, animals, and ecosystems in the context of OS	– minimize risks to research participants, environment, plants, animals, and ecosystems when practicing OS
	– apply quality criteria for open data and recognize the need for quality control before publishing open data	– responsibly perform quality control before publishing open data and ask for support from senior colleagues and/or data protection officer, if necessary
	– be aware of importance of the quality of open data sets and research outputs in OS and their responsible use	– responsibly and critically assess, use, and analyse open data and research outputs – make references to and acknowledge authors of open data sets and other research outputs
	– apply 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 – identify responsible open access practices

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3.3 Experienced researchers

	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 significance of OS and citizen science for identifying and solving scientific problems and societal challenges	– teach, explain, and discuss the role of OS and citizen science in identifying and solving scientific problems and societal challenges
	– know their responsibilities in teaching OS practices and monitoring OS practices implemented by students and early career researchers	– responsibly teach and monitor OS practices implemented by students and early career researchers
	– know potential types of research malpractice in OS	– recognize research malpractice in the context of OS, discuss its causes and ways of prevention
	– be able to analyse the risks to data safety/security in the context of OS and be informed about methods and tools for minimizing these risks	– choose, teach, and apply appropriate methods and tools for data protection in OS
	– be able to analyse the risks to research participants, environment, plants, animals, and ecosystems in the context of OS	– minimize risks to research participants, environment, plants, animals, and ecosystems when practicing OS and support colleagues in this process
	– apply quality criteria for open data and recognize the need for quality control before publishing open data	– responsibly perform quality control before publishing open data and support colleagues in this process
	– understand the risks to data safety/security in the context of OS and be informed about methods and tools for minimizing these risks	– choose and apply appropriate methods and tools for data protection in the context of OS and support colleagues in this process
	– apply 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 – recognise limits of OS for protection of data and intellectual property rights – initiate and lead discussions on cases with colleagues

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3.4 Citizen scientists

	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 OS value, 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
	– understand the risks to data safety/security in the context of OS and be informed about tools for minimizing these risks	– explain importance of methods and tools for data protection in the context of OS and citizen science
	– understand the risks to research participants, environment, plants, animals, and ecosystems in the context of OS	– minimize risks to research participants, environment, plants, animals, and ecosystems when practicing OS
	– understand the concept of conflict of interests and how to deal with it	– recognize and disclose conflicts of interests in cases when citizen scientists have personal or political interests at stake
	– 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
	– be aware of responsibilities of citizen scientists for data quality and integrity	– explain how biased, fabricated, falsified or poor-quality data could undermine the validity of scientific research
	– demonstrate knowledge how to ensure quality of open data	– collect data responsibly and keep complete and accurate records
	– apply critical thinking skills - questioning, comparing, summarizing, drawing conclusions, and defending - to case studies on ethics and integrity in OS and citizen science	– 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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4 Topics to be included in training materials

4.1 General topics for all trainees

Ethical and societal foundations of OS, its purpose	•Emerging, history and justification of OS •Benefits and value of OS for different stakeholders •Main challenges in OS implementation
The quality of the research outputs and data sets	•Responsibility of researchers for quality of the collected, processed and stored data •Responsible preparation and management of data sets and metadata
Protection of research participants' rights in OS	•Specifics of informed consent in OS •Responsible anonymization and pseudonimization •Tension between personal data protection and aim of OS
Prevention of research malpractices in the context of OS	•Types of potential research malpractices in OS •Prevention of research malpractices in OS
Responsible sharing and use of open data	•Trust and trustworthiness in OS •Responsible storing and use of open data •Open sharing of data, materials and codes
Responsible dissemination/publication practices	•Benefits and risks in open peer review •Responsible publication of preprints •Open access, open access publishing, predatory practices
Protection of intellectual property in the context of OS	•Intelectual property and fair competition •Authorship and acknowledging •Open Licences
Ethical aspects of citizen science in the context of OS	•Responsibilities of citizen scientists •Scientists' responsibilities towards citizen scientists •Ethical aspects in communication and collaboration with citizen scientists

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4.2 Additional topics for specific fields of science

4.2.1 Social sciences

Topic	Questions
Respect for participants' autonomy in open social sciences	What are the requirements for informed consent in the context of OS? How to inform research participants about open sharing of data? What are specific requirements for consent/assent of vulnerable populations in the context of OS?
Open sharing of quantitative and qualitative data	How to responsibly share quantitative data in social sciences? Is it possible to responsibly share qualitative data? How?
Anonymization and pseudonymization of open data	How to ensure confidentiality of data? What are the available anonymization and pseudonymization techniques and their applicability for quantitative data in social sciences? Is it possible to anonymize qualitative data? If so, how?
Data mining	What are ethical aspects of use of artificial intelligence and machine learning in analysing open data in social sciences?
Citizen science in open social sciences	Why is citizen science important in social sciences? What are ethical challenges in practicing citizen science in social sciences? How to plan a citizen science project responsibly? How to involve citizen scientists in a social sciences research project?
Including OS aspects in assessing researchers	How to include and reward OS practices in hiring approaches and policies in social sciences? What are the benefits and risks? What are the best practices?

4.2.2 Natural sciences

Topic	Questions
Protection of plants, animals and ecosystems in OS	What are the risks for plants, animals and ecosystems when openly sharing data, especially geolocation data? How to minimize these risks? How OS can be used as tool to decrease the use of animals in research?
Dual use of open data in natural sciences	How to identify dual use issues? How to prevent misuse of open data?
Data mining	What are the ethical aspects of the use of artificial intelligence and machine learning in analysing open data in natural sciences?

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Citizen science in natural sciences	Why is citizen science important in natural sciences? What are ethical problems in practicing citizen science in natural sciences? What is the role of scientists in developing responsible citizen science projects?
Including OS aspects in assessing researchers	How to include and reward OS practices in hiring approaches and policies in natural sciences? What are the benefits and risks? What are the best practices?

4.2.3 Humanities

Topic	**Questions**
Digital humanities and OS	Is it possible in digital humanities to employ the general approaches used in OS? How to responsibly use open-source tools in digital humanities?
Anonymization and pseudonymization of open data	What are the available anonymization and pseudonymization techniques and their applicability for data in humanities?
Data mining	What are ethical aspects of use of artificial intelligence and machine learning in analysing open data in humanities?
Citizen science in humanities	Why is citizen science important in humanities? What are ethical problems in practicing citizen science in humanities? What is the role of scientists in developing responsible citizen science projects?
Including OS aspects in assessing researchers	How to include and reward OS practices in hiring approaches and policies in humanities? What are the benefits and risks? What are the best practices?

4.2.4 Health and life sciences

Topic	**Questions**
Respect for participants' autonomy in biomedical research	What are the requirements for informed consent in the context of OS? How to inform participants about open sharing of health data? What are specific requirements for consent/assent of vulnerable populations in the context of OS?
Open sharing of genetic and genomic data	How to ensure confidentiality of data? How to protect genetic and genomic data in the context of OS? How to shape consent in the context of genetic and genomic data?

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Anonymization and pseudonymization of open data	What are the available anonymization and pseudonymization techniques and their applicability for data in health and life sciences?
Dual use of open data in health and life sciences	How to identify dual use issues in health and life sciences research? How to prevent misuse of open data?
Data mining	What are the ethical aspects of use of artificial intelligence and machine learning in analysing open data in health and life sciences?
Citizen science in health and life sciences	Why is citizen science important in health and life sciences? What are ethical problems in practicing citizen science in health and life sciences? What is the role of scientists in developing responsible citizen science projects?
Including OS aspects in assessing researchers	How to include and reward OS practices in hiring approaches and policies in health and life sciences? What are the benefits and risks? What are the best practices?

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5 Teaching and learning strategies

To achieve optimal results, the ROSiE training materials will rely on several learning and teaching strategies that the authors consider most effective and useful for the purpose: (i) collaborative problem solving; (ii) case-based activities; (iii) dialogical activities; (iv) transformative learning.

1. Collaborative problem solving

Collaborative problem solving is one of the main learning and teaching strategies to be used in the ROSiE training materials. Authors of the 21st Century Skills define collaborative problem solving as "*approaching a problem responsively by working together and exchanging ideas*" and emphasize that the approach is based on "*readiness to participate, mutual understanding, and the ability to manage interpersonal conflicts*". (Hesse et al., 2015) The 'collaborative learning' is contrasted to 'cooperative learning' where problem solving usually is performed by dividing tasks and working parallelly. When practicing collaborative problem solving, "*[t]he activities from learners are inextricably intertwined, contributions by learners mutually build upon each other, and one learner's actions might be taken up or completed by another*". (Hesse et al., 2015) This approach allows to include a variety of perspectives and experiences, practice mutual support among trainees and enhance the quality of solutions. Taking into account the collaborative character of OS, diversity of actors and stakeholders involved and complexity of ethical and integrity aspects of OS, collaborative problem solving offers an effective tool for teaching and learning which is applicable to real-life situations.

2. Case-based activities

Case-based activities is another widely used teaching and learning strategy with proven value and effectiveness in research ethics (Tammeleht et al., 2019) building an "*effective way to get students involved in the issues*" (Pimple, 2007). Based on the literature analysis, and experience of the consortium members and stakeholders, we will develop a collection of cases in ethics and integrity of OS and supplement these case studies with background information and questions for discussions. Case-based activities will include both individual reflection on cases, active discussion of cases in larger groups and collaborative problem solving activities (Hesse et al., 2015; Todd et al., 2017).

3. Dialogical activities

The roots of dialogical teaching and learning in ethics go back to the Socratic method. The approach of 'Neo-Socratic dialogue' was developed by philosopher Leonard Nelson and further developed by his followers. (Saran & Neisser, 2004) This approach starts by asking an abstract philosophical question (e.g., what is a good scientific practice?) which is followed by asking participants to give specific examples from their own experience

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relevant to the question, then one or several examples are used for facilitated group discussion. The trainees are encouraged to develop collaborative analysis, apply active listening and demonstrate respect and attentiveness. (Saran & Neisser, 2004) Other forms of dialogical activities include moral case deliberation strategy. (Molewijk et al., 2008) The moral case deliberation consists of "*a collaborative, systematic reflection*" (Molewijk et al., 2008) on a real case where the facilitator acts in a non-directive manner and "*concentrates on the quality of the deliberation process and the meaningfulness of the moral issues*" leading to development of collaborative problem-solving skills and reflective attitude. (Molewijk et al., 2008)

4. Transformative learning

Internalization of values is one of the most important and most difficult tasks in teaching and learning ethics and developing a 'moral compass'. Transformative learning is one of the strategies encouraging internalization of values which is broadly used in adult education. The approach was developed by Jack Mezirow and aims at challenging the learners perspective, revising the pre-existing values or beliefs of a person and changing the way a person experiences and conceptualizes problems. (Mezirow, 1991, 2000) By following this strategy, learning starts with a 'disorienting dilemma' - a situation that challenges learners personal world views and is a catalyst for personal transformation. (Mezirow, 1991) To implement the strategy of transformative learning, we will develop examples of disorienting dilemmas dealing with ethics and integrity issues in OS and suggest ways how to discuss these dilemmas to foster transformative learning.

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