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Open and citizen science for enhancing skills of HE educators

A guidebook for training educators at your university

Credits

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List of Abbreviation

Abbreviations	Description
CS	Citizen science
DMP	Data Management Plan
HEI	Higher education institution
OER	Open Educational Resources
OEP	Open Educational Practices
OS	Open Science

Introduction

Why HEIs should integrate OS and CS activities into pedagogical design?

Higher Education Institutions (HEIs) play a key role in fulfilling the vision of Open Science (OS) and Citizen Science (CS) because they are educational and scientific bodies and regional innovation builders. They work as a central part of the various types of OS implementation by executing policies, operating services, providing support at the institutional level (Zourou, 2020) and delivering positive social, economic, and cultural impacts on society. (Väänänen & Peltonen, 2016). Through the OS processes, HEIs can collaborate with various stakeholders and make science open to them, enabling the turning of knowledge into practice to tackle societal, economic, and environmental challenges. Accordingly, the European University Association (EUA) emphasises the impact of HEIs on society and advocates the need for altering HE curricula to respond to global needs and problems (see EUA, 2017; EUA, 2020). One way to fulfil the goals is to design learning activities in which students can learn and deal with the challenges in more open and collaborative ways. Hence, it is important to encourage HEIs to integrate OS and CS activities into their pedagogical design.

However, few universities successfully act to implement OS and CS in their teaching practices at an institutional level. Although they have good foundations, such as technical infrastructures and professional communities, those resources are not fully utilised in education due to a lack of knowledge and mindsets for OS among the educators.

The INOS project consortium conducted a survey to investigate the level of active citizenship competence of the participants in the past 12 Open Knowledge Activities (OKAs) (see Pata, 2022). A total of ninety participants, including HE educators, OS experts, HE students and other participants (e.g., teachers from secondary schools) voluntarily answered the survey. The results show that the HE educators showed lower competencies or values in OS concepts, especially citizen involvement in the scientific process, such as re-using the data and crowdsourcing (e.g., questions 2, 4, and 5) (see Figure 1).

One of the reasons for the results is a lack of practical guidance and training for academic staff, especially those in teaching positions, to help them learn OS/CS concepts and utilise them in their work. Therefore, the INOS consortium aims to transfer the experiences and knowledge on teacher training produced through the project to help HEIs successfully implement OS/CS concepts in academic teaching practices.

Figure 1. The comparison of active citizenship competencies among the participants in open knowledge-building activities. Retrieved from Pata (2022).

This guidebook will tell the readers what OS principles are, how valuable it is for students, and how to train teachers to understand and integrate the concept into the learning activities.

We hope it will help the readers see the potential of OS in education and change their mindsets to incorporate OS in their educational practices.

How to use this guidebook?

This guidebook provides practical tips on training HE teaching staff to integrate OS (and CS) in their academic teaching practices. University administrators in charge of pedagogical development and teacher (employee) training are the main targeted readers. It is also useful for teachers because the content covers various practical issues such as the learning design process, materials, and tools. In addition, other academic staff members such as researchers, project workers, and academic librarians could find it beneficial for their work.

First, we recommend you read the first chapter: *Before you start: what are the goals for OS implementation?* to familiarise yourself with the latest definition of OS and its values in HEIs. You can skip this chapter and jump to the main training part if you are already familiar with the concept.

The main part is composed of four chapters (phases), and each one includes small steps to design a specific set of actions.

1. Preparation phase

2. Training phase

3.Implementation phase

4. Follow-up phase

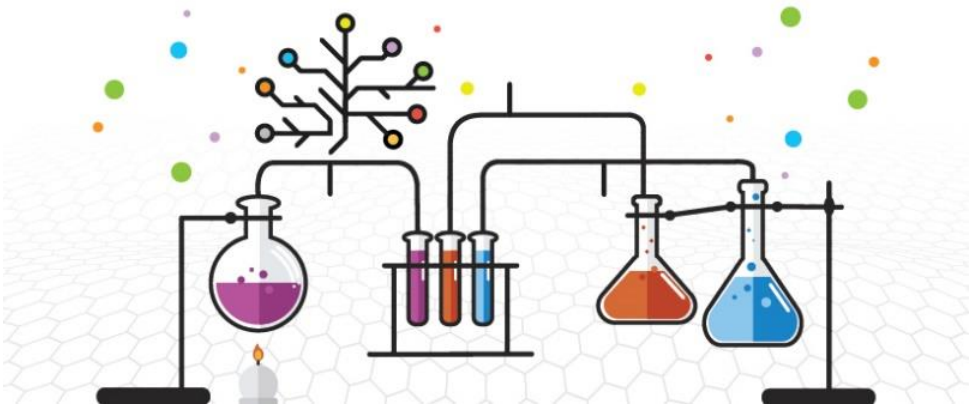
In the preparation phase, you can find ideas of what is needed as foundations to implement OS before training teachers. The contents are more relevant to the senior management positions, for example, those who can take the initiative to form up a project team and drive a strategic training plan at an institutional level.

The training phase guides you in making teachers aware of the OS concept and engaging them in the related activities. This chapter also tells why OS principles are important in education and how it is beneficial for students to motivate teachers to implement them in their teaching.

Then, we propose our Learning Design Framework and help teachers build pilot learning activities independently in the implementation phase. Teacher trainers are encouraged to provide hands-on training activities where teachers are the main actors and start designing OS/CS integrated learning activities with colleagues. This chapter also provides a compilation of useful digital tools utilised in the real learning activities of our past OKAs and OIAs.

Lastly, the follow-up phase suggests reflection activities to find success factors and challenges to improve the activities for the next round. Trainers are encouraged to design and organise a joint reflection session for the teachers by doing a facilitator job.

After the main part, we introduce OS communities in Europe. We highly encourage you to build such a community in your institution because it is a very good way to cultivate OS cultures across the institutions. For instance, the network created through this teacher training programme can be maintained through the OS community. With this community, the participating teachers can continuously develop their teaching activities by communicating with other community members.



Tips

- Weblinks for related materials and useful information are provided in a box with a tool icon.

Useful links

- Some practical tips are provided in a box with a TIP icon.

TIP

- Guiding questions and checklists aim to trigger effective discussion on the topic.

- Reading this book in PDF format is suggested so that you can directly jump to the relevant materials and websites.

- However, after the implementation phase, we ask the readers to refer to our INOS Learning Design Framework (LDF) to design and evaluate the learning activity. Thus, printing the document and handing out to teachers is highly recommended.

You can download LDF from here.

Before you start: what are the goals for OS implementation?

The OS movement has been more active and valued, fostering universities to be more open and connected to society. The trend has been affecting a funding body's decision making (i.e. the founders appreciate more the projects complied with OS principles), which is another trigger for HEIs to promote OS implementation. Thus, readers of this guidebook may also be striving for a successful implementation of OS at the institutional level. However, OS is a broad umbrella concept that includes various types of open principles from research to education.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) defined OS in their recent publication, *a UNESCO Recommendation on Open Science in November 2021*, as follows:

> *"Open science is defined as an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community"* (UNESCO, 2021, p.7).

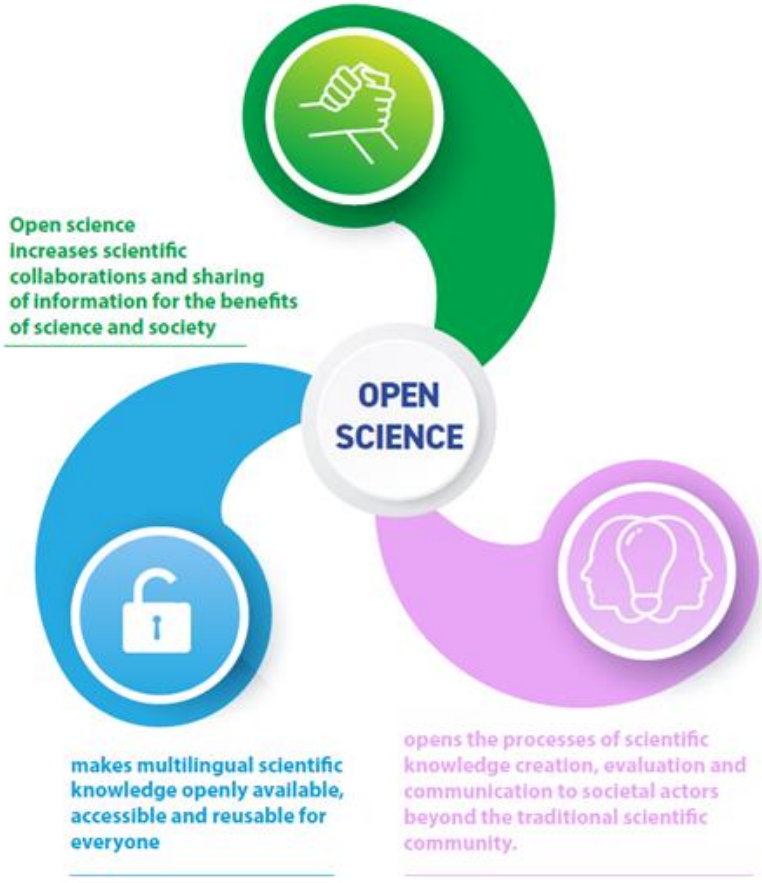


Figure 2. A broad concept of Open Science. Retrieved from UNESCO (2021).

A similar term, 'Citizen Science,' shares the same concepts; public involvement can widen the possibilities of science, make it open and transparent and transfer scientific knowledge into society. It is one element of OS concepts but could be the most concrete way to fulfil the OS visions because the process of Citizen Science embraces various other elements such as Crowdsourcing, Open Data and Open Access, and Open Knowledge Activities. Citizen volunteers can contribute to science processes such as data collection and analysis, answer their own scientific inquiries, acquire new knowledge, and collaborate with researchers and other citizen scientists through the projects. CS is one of the eight ambitions identified by the European Commission[1].

[1] European Commission. (n.d.). 8 ambitions of the EU's open science policy https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en#8-ambitions-of-the-eus-open-science-policy

It is important to acknowledge that OS comprises any kind of scientific discipline from sciences to humanities and scholarly practices at basic and applied levels (UNESCO, 2021); therefore, all the faculties of your university can participate in the OS implementation and benefit from it. However, implementing OS practices perhaps sounds demanding because of openness. OS consists of a wide range of principles from research-oriented to education or innovation-oriented, the whole concept may feel complex and confusing, making it difficult to decide where to start.

Hence, we suggest making a strategic plan to permeate your institution's OS and OS-integrated teaching practices holistically. Collaboration across different disciplines and departments and cultivation of culture among the staff members are keys to successful implementation at the institutional level. You will find actionable steps from the next section suggested by the INOS project partners!

Useful links

Of what is Open Science composed?

- Open Science Guidelines by FOSTER

What is Citizen Science?

- Ten Principles of Citizen Science by the European Citizen Science Association (ECSA)

Relevant publications by INOS

- Examples of Citizen Science Activities:
  Academia permeating society through Citizen Science: Use cases of engagement in Higher Education
- Examples of Open Innovation Activities:
  Compilation of use cases of open innovation activities to be addressed

1 Preparation phase

STEP 1-1: Form a strong project team

A reader of this guidebook may be working in an administrative or teacher training position in HEIs, or another department that supports OS activities, such as an academic library. Most likely, you envision promoting the application of OS and extending it to academic education at your institution. However, just yourself or a few colleagues is not enough to make a drastic organisational change, especially on this broad, open topic that includes various elements. Since OS is realised through a wide, diverse connection across disciplines, departments and organisations, the inclusion of diverse HE staff is crucial. Therefore, we recommend the following actions to run a project team:

Action 1. Get people on board across faculties

The ideal team should include people from various disciplines and divisions, roles, and positions to benefit from the diversity. For example, the team can consist of a few people from the administration of the institution (e.g., educational development), teacher trainers, representatives from faculties (both science and arts disciplines), data management positions (e.g., data steward) and academic librarians. A multidisciplinary team can reach out to various networks, fostering cross-faculty collaborations and extending the range of activities. The diversity also helps permeate the new practice throughout the institution, where each faculty has different operational practices.

Action 2. Define the goals of the project

It is very important to agree on common goals and share the objectives within a team. Especially if the team is composed of people from different faculties, their practice and prior knowledge of OS may differ. Making a simple slogan works well to share the core vision and mission within the team, which can strengthen team cohesion!

Action 3. Build a channel to communicate and disseminate the information

The The next step could be to organise a shared communication channel internally and externally. An internal channel means a communication place only for the project team, and an external channel includes the teachers and others who get training from your team. For example, you can create a group on Microsoft Teams (or another platform your institution uses) that includes both a private channel and an open channel to communicate internaly and disseminate relevant information and training materials openly. Alternatively, you can create a separate page on the institution's website to attract teachers and provide information to them.

Action 4: Make an annual plan and milestones

All the staff members must be busy with their primary work. This kind of side project can easily be put aside, although it is very important for the institution. Thus, it is highly recommended to create an annual plan to avoid such failure, for example, setting monthly meetings already for a semester and milestones and KPIs (Key Performance Indicators) of the project.

Figure 3. Image by Open Science Community Starter Kit, licensed under CC BY-NC-SA 4.0 (Retrieved from https://www.startyourosc.com/).

TIP

In addition, the last chapter of this guidebook introduces OS communities in Europe and its Starter Kit. OS community is run by a university, connecting various stakeholders ranging from researchers to students to communicate and organise OS-related activities. If your university aims to permeate OS culture across the institutions, please check it out!

STEP 1-2: Analyse the state of OS/CS in your institution

Before starting to design training for teachers, let's check the current state of your institution. There might have already been some successful cases in the university that you haven't known. For example, if you are working in the Faculty of Education, you may not be familiar with the Faculty of Biology. It's worth talking with other faculty members as they may have deeper knowledge and experiences in OS. This analysis can help reach out to the appropriate persons or groups in your institution and facilitate further discussion.

Guiding questions can be:

- How much is OS known in your university?
- How are they valued or implemented?
- In which field is OS most successfully implemented?
- How much are teachers and lecturers aware of the value of OS/CS?
- Are there any precedents that integrated OS/CS activities into teaching practises?

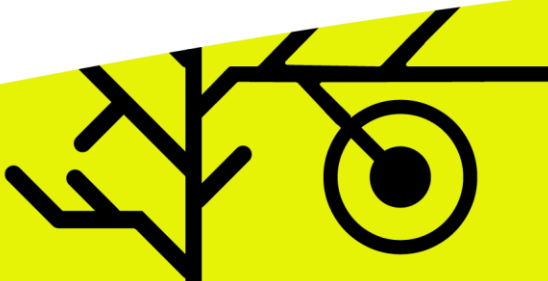
You can send an online survey to teachers through faculty administrations to collect existing OS/CS integrated teaching practices in your university. The examples may include a study module to teach OS principles (e.g., open access, open data etc.), a problem-oriented course involving multiple sectors or a lecture using open-source software or open educational resources. Gather teachers in charge of these cases and brainstorm benefits, problems, successful and failure factors in the implementation.

Checklist

Do we have/use …

- ✓ experiences of participating in or organising a CS project?
- ✓ teaching practices that integrate or relate to OS? (e.g., CS, Crowdsourcing, Open Data, Open Software, Open Educational Resources)
- ✓ courses that facilitate a cross-communication between students and researchers/ citizens/external stakeholders?
- ✓ connections with other public or private organisations? (e.g., museums, libraries, research institutes, start-ups etc.)

In addition to answering those broad questions, you can also reflect on more specific questions to determine the level of OS implementation. For instance, you can check the level of OS competencies for researchers in your institution with the



guidelines from the Transparency and Openness Promotion (TOP) Committee (2015). This framework allows checking the current level of openness in scientific publication processes ranging from citation to replication by four levels; 0 to 4 (see a table below).

The original source of the table can be found here: TOP-factor-rubric

The detailed guidelines can be found on TOPGuidelines

Summary of the eight standards and three levels of the TOP guidelines

Levels 1 to 3 are increasingly stringent for each standard. Level 0 offers a comparison that does not meet the standard.

	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Citation standards	Journal encourages citation of data, code, and materials—or says nothing.	Journal describes citation of data in guidelines to authors with clear rules and examples.	Article provides appropriate citation for data and materials used, consistent with journal's author guidelines.	Article is not published until appropriate citation for data and materials is provided that follows journal's author guidelines.
Data transparency	Journal encourages data sharing—or says nothing.	Article states whether data are available and, if so, where to access them.	Data must be posted to a trusted repository. Exceptions must be identified at article submission.	Data must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Analytic methods (code) transparency	Journal encourages code sharing—or says nothing.	Article states whether code is available and, if so, where to access them.	Code must be posted to a trusted repository. Exceptions must be identified at article submission.	Code must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Research materials transparency	Journal encourages materials sharing—or says nothing	Article states whether materials are available and, if so, where to access them.	Materials must be posted to a trusted repository. Exceptions must be identified at article submission.	Materials must be posted to a trusted repository, and reported analyses will be reproduced independently before publication.
Design and analysis transparency	Journal encourages design and analysis transparency or says nothing.	Journal articulates design transparency standards.	Journal requires adherence to design transparency standards for review and publication.	Journal requires and enforces adherence to design transparency standards for review and publication.
Preregistration of studies	Journal says nothing.	Journal encourages preregistration of studies and provides link in article to preregistration if it exists.	Journal encourages preregistration of studies and provides link in article and certification of meeting preregistration badge requirements.	Journal requires preregistration of studies and provides link and badge in article to meeting requirements.
Preregistration of analysis plans	Journal says nothing.	Journal encourages preanalysis plans and provides link in article to registered analysis plan if it exists.	Journal encourages preanalysis plans and provides link in article and certification of meeting registered analysis plan badge requirements.	Journal requires preregistration of studies with analysis plans and provides link and badge in article to meeting requirements.
Replication	Journal discourages submission of replication studies—or says nothing.	Journal encourages submission of replication studies.	Journal encourages submission of replication studies and conducts blind review of results.	Journal uses Registered Reports as a submission option for replication studies with peer review before observing the study outcomes.

Figure 4. A summary table of the TOP guidelines. Retrieved from Nosek et al. (2015).

STEP 1-3: Plan a training

The Now it's time to design actual training for teachers! If you are in a senior position, such as an administrator or manager, this section helps you design effective and engaging training for teachers. If you are a teacher seeking tips to integrate OS into teaching, you can jump to the next section to start learning OS and its values in active learning approaches.

Training duration and goals

The participating mode and duration of the training vary depending on the goals. It could be a one-time seminar, intensive workshop or a series of activities throughout the semester. When designing training, you should consider the main purpose of the training; is it disseminating the idea to a large audience? Or is it developing participants' certain skills and competencies? The main goal of the reader could be to encourage educators to apply the OS principles to their teaching practices rather just to transmit the knowledge of OS to them. Therefore, we highly recommend you set a long-term vision and design a series of training sessions as a comprehensive development process.

Specialists and mentors

If your institution has an expert in any OS concept, contact the person to ask for help. If possible, involve these experts as mentors for the teacher training program. For instance, there might be an Open Science specialist who could provide useful resources, introduce related associations and guide the participants during the training. Alternatively, a data steward can evaluate the teacher's designed learning activities from the data management point of view and advise on it. Academic librarians can be great mentors since the academic library works as a hub to connect all the faculties and support the fundamental infrastructure of OS.

External resources

In addition to the internal resources, you can also find training programs or useful learning materials outside the university. It is good to include those external organisations because teachers can get aware that this movement of OS is not just an internal-scale vision but is a worldwide (especially European leading) change towards the future. For example, LIBER Europe (https://libereurope.eu/; Ligue des Bibliothèques Européennes de Recherche – Association of European Research Libraries) disseminates various useful information about OS principles and organises related webinars for free of charge. If you need support and up-to-date information for your country, you can find National Open Access Desks (NOADs) on OpenAIRE (https://www.openaire.eu/). It is worth contacting the national specialist and asking for some tips for training design for your institution.

Caption: Participants at the LIBER 2019 Annual Conference in Dublin

Photo credit: LIBER Office

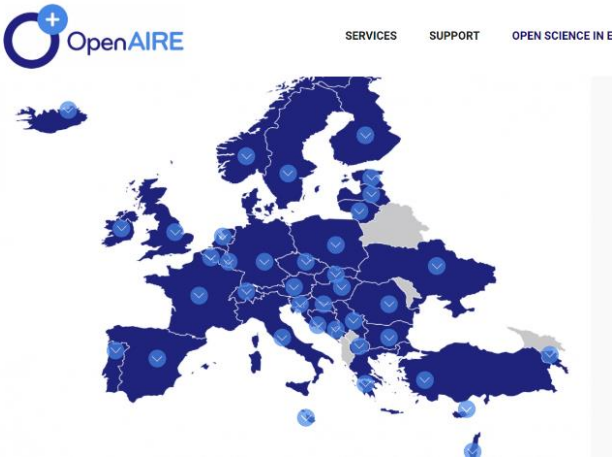


Figure 5. National Open Access Desks (NOADs). A screenshot of the OpenAIRE website (https://www.openaire.eu/os-eu-countries).

Sustainable community and development structure

It is already good to start thinking about the end of the training period; how to keep the impact of the project after its end. More specifically, most temporary projects lose the following things after ending the active operation period:

- Shared working spaces
- Related materials
- A community built through the project
- Participants' motivations toward the topic

Ideally, the project outcomes can stay open and keep delivering the impact to the new target participants in a sustainable manner. The easiest way is to create an internal webpage or channel to store the learning materials, such as records of a set of webinars. This approach enables academic employees, including newcomers, to access the resources and develop their competencies by themselves.

Another possible way is to create an organisational OS Community by collaborating with an academic library and other related organisations (e.g., research or educational institutions). The merit of this approach is that you can keep the formed ecosystem and even expand the potential, which can cultivate OS cultures across your institution. However, the admins' continuous efforts are required to run the community. You can find the details of the community in the last section of this guidebook.

2 Training phase

STEP 2-1: Make teachers aware of the value of OS/CS

From this chapter, you can get some ideas about the contents of teacher training. First, you may ask teachers and other training participants how familiar they are with the OS concepts.

Guiding questions can be:

- Do they know/understand what OS is?
- Are they aware of the positive aspects of OS in science and education?
- Can they imagine how it relates to society (non-academic field)?
- Can they see how OS is beneficial for our institution and students?

OS/CS activity triggers student-intrinsic motivation and curiosity

The Citizen Science approach is a great way to design student-centred and problem-oriented learning with inducing students' intrinsic motivation. Curiosity towards the subject increases situational interest, positively impacting student attitude and motivation towards learning, leading to better engagement and deeper learning (Flowerday et al., 2004). For instance, participants generally find real-world data more interesting than artificial data sets for a learning activity (e.g., Borrell et al., 2016; Dix & Ellis, 2015; Teo, 2020a). By participating in data collection (e.g. WaterAct) or utilising a real dataset (e.g. Transcribe Bentham), students can

TIP

Why is it valuable to integrate OS into teaching?

Teachers can learn about OS through training; however, do they find value in their teaching? One possible pitfall is that teachers cannot find a connection between OS and teaching practices and consequently, not being motivated to implement it into their daily work. Thus, it is important to emphasise the benefits - how OS and CS approaches can enhance student engagement in learning and facilitate acquiring required skills in future, so-called 21st-century skills.

get involved in real-world scientific research projects and cultivate their curiosity and inquiry attitudes. In Open Innovation (OI) based learning activities, students can meet the target end-users and directly hear their real problems (e.g. Service learning course by KU Leuven). This approach enables students to find the usefulness of their knowledge and its connection to society. More examples of OS-integrated learning activities (HE curricula) can be found in our previous deliverable (see Nakata, 2022).

Both approaches have in common that the learning topics and objectives depend on the student and could be different among students in the same classroom. Each student or a group has responsibilities for their own learning processes, e.g., setting goals, planning and time scheduling, implementing the plan and creating a final presentation. As a result, students can learn and acquire a scientific inquiry attitude, task organisation, accountability for their own projects and teamwork through such processes (Bell, 2010).

Student-centred learning design can cultivate inquiry attitudes and project organising skills

These days, the demand for student-centred learning design has been increasing in many subjects since teachers know that a one-size-fits-all approach does not work anymore. The classroom becomes increasingly adaptive to fulfil each student's different learning goals and needs, considering different levels of knowledge and skills. Integrating OS-oriented active learning approaches could be a good solution to realize such an adaptive learning environment!

For example, Project-Based Learning (or Challenge-Based Learning) allows students to choose for themselves the most interesting topics. It facilitates their own organising skills to accomplish the project, most likely, to generate a new solution. In Inquiry-Based Learning, students can set their own research questions and explore the phenomena by attending data collection and analysis like a real scientist.

Collaborative learning enhances students' social skills necessary for their working lives

A collaborative learning approach has been increasingly used in various educational settings, especially higher education. With this method, students can learn new things and refine their knowledge through interactions with other pupils by exchanging different perspectives on the topic (Teasley 1997; Vygotsky 1978). Wood (2003) states, "Group learning facilitates not only the acquisition of knowledge but also several other desirable attributes, such as communication skills, teamwork, problem-solving, independent responsibility for learning, sharing information, and respect for others'' (p. 328). Since students must encounter various ‘differences’ in a collaborative learning situation, they should tolerate them, negotiate by respecting each opinion and care for other peers as a team, which are crucial abilities in life with the community (Smith & MacGregor, 1992).

Active learning approaches can generate rich collaborative learning opportunities. For example, a discussion-based learning activity can facilitate students' knowledge co-construction processes, especially the skills of reasoning their own viewpoints, accommodating others' perspectives and initiating constructive argumentation. A project-based (challenge-based) learning activity can provide a real social context where students must communicate with external stakeholders and create a new solution together. Incorporating OS and active learning methods into learning design is a good idea if you seek a way to induce peer interaction and collaboration. You can learn more about a design framework in the Implementation section.

OS enhances digital competencies and data literacy

On the internet, various types of open data, open source, and open software are available free of charge so that teachers can utilise these resources in their learning activities. For example, students can re-analyse real data from the existing research to confirm the replicability of the reported phenomena (e.g., Jekel et al., 2020) or clean the dataset to seek out the hidden phenomena (e.g., Dix & Ellis, 2015). They can have a genuine experience of scientific work and practical skills through re-using a real dataset. Such work requires advanced digital literacy and data handling skills. Both teachers and students can cultivate their competencies by utilising such open resources.

Caption: Participant at the LIBER 2018 Annual Conference in Lille.

Photo credit: Alexandre Caffiaux

Useful links

Relevant publications by INOS

- Examples of OS/CS/OI integrated learning activities:
  State-of-the-art analysis of the pedagogical underpinnings of open science, citizen science and open innovation activities
- Examples of OS/CS/OI integrated HE curriculum design:
  State-of-the-art report on the integration of OS (and CS) in existing HE curricula

STEP 2-2: Promote participation in OS and CS activities

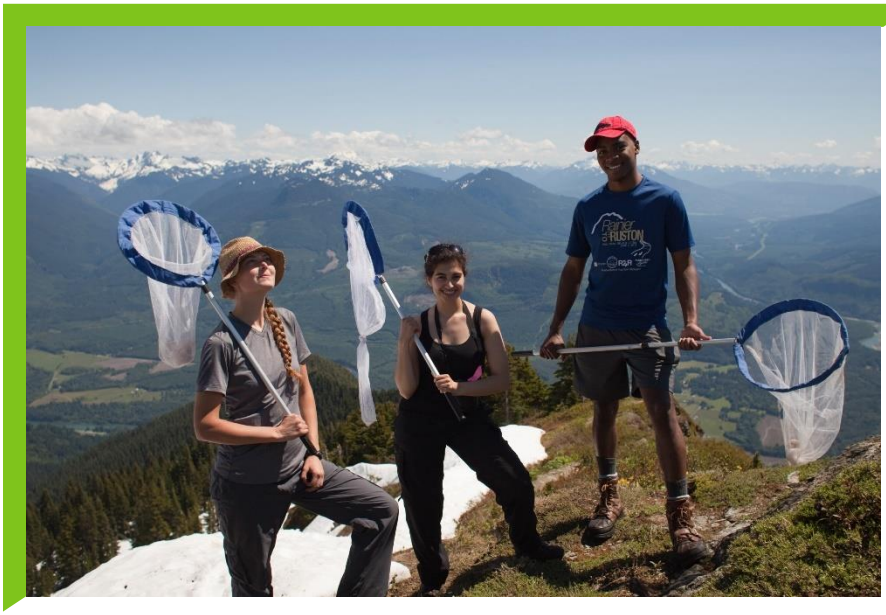
Teachers should know what they are teaching to students; therefore, we highly recommend that the teacher trainers encourage the teachers to participate in OS and CS activities. Learning by doing is the most powerful way to learn a new thing, and it is also the case for teachers (and trainers as well, if you are not yet familiar with OS)! The way of participation and the level of involvement varies such as:

- becoming a citizen scientist mapping data (e.g., natural, historical, or anthropological resources)
- re-using and analysing Open Data
- utilising Open Access publications and resources
- participating in Open Innovation hackathon events
- participating in Open Knowledge Activities
- creating Open Educational Resources

Through the participation processes, you can learn the fundamental principles of OS, the structures and mechanisms of the project and the benefits and problems in the activities.

It is also beneficial for researchers, for example, to participate in a CS project since they can find a way to recruit and engage citizen scientists in data collection. For example, they can learn how to collect inaccessible data (e.g., reaching out to a local community) or massive amounts of data (e.g., engaging citizens with a gamified approach).

You can find some useful platforms where people can openly access interesting projects and relevant resources on the next page!



Caption: Members of the Cascades Butterfly Citizen Science Project Team

Photo credit: Karlie Roland.

EU-citizen.science (https://eu-citizen.science/)

EU-Citizen Science is an online portal for sharing knowledge, tools, training and resources for citizen science – by the community, for the community. On this platform, you will find:

- Projects that are engaging the public in research via citizen science activities
- Resources that are useful for citizen science practitioners
- Training resources and materials on citizen science as a practice
- Training modules on citizen science in a wide range of themes
- Organisations that are involved in citizen science projects and research
- Events calendar
- A blog
- Forum for questions, conversations, and collaboration with the rest of the community

Figure 6. A screenshot of the eu-citizen.science website (https://eu-citizen.science/).

European Open Science Cloud (https://eosc-portal.eu/)

European Open Science Cloud (EOSC) is an online platform to provide European researchers, innovators, companies and citizens with a federated and open, multidisciplinary environment where they can publish, find and re-use data, tools and services for research, innovation and educational purposes.

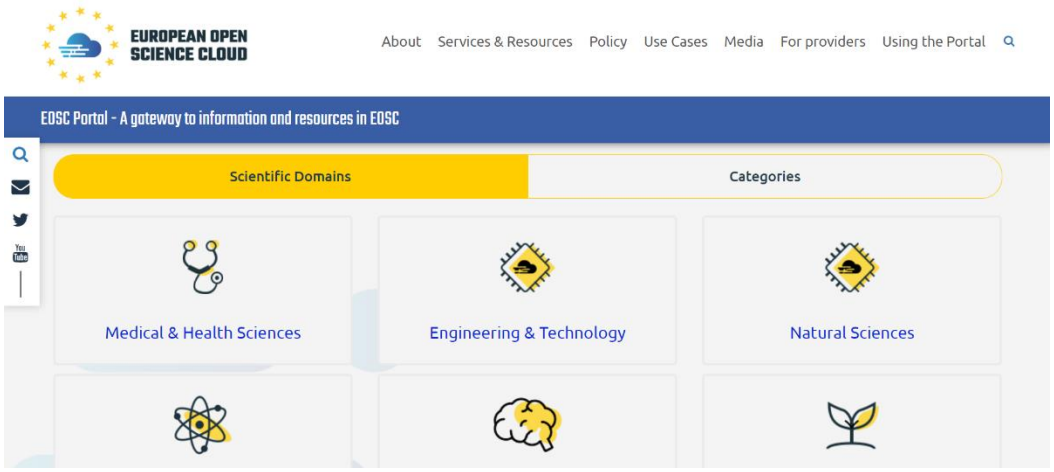


Figure 7. A screenshot of the EOSC website (https://eosc-portal.eu/).

STEP 2-3: Enhance teachers' data literacy

'Data management' has been a controversial topic in this digital era. It is also a very important issue in HEIs where a massive amount of sensitive data has been handled in a research process. Data handling is inevitable in OS processes because accessibility and reusability of data is a core concept of OS. To comply with national and EU-standard data protection policies, each educational institution needs to implement data management strategies across the faculties, training staff members to be competent with data handling.

If you are not familiar with data handling and management, you can learn basic principles from the below useful links.

General Data Protection Regulation (GDPR)

The GDPR are the fundamental principles of data protection in the European Union. Especially if your institution is in an EU country, we highly recommend training your staff members to familiarise themselves with the principles such as handling personal data and sensitive data.

Basics of Open Access and Open Data

Open AIRE guides visitors to learn Open Access and Research Data Management (https://www.openaire.eu/support). They also offer helpdesk services and training webinars and workshops. Including such training sessions in your teacher training course design is recommended.

You can check the current data-sharing, handling and management practices in your institution with the following questions.

Checklist

Does our institution have …

- ✓ data management policies?
- ✓ an open data repository?
- ✓ a data steward?
- ✓ instructions for the writing process of the Data Management Plan?
- ✓ open science specialist or relevant department?
- ✓ secure working platform for external stakeholders in terms of data regulation?

FAIR Data Principles

The FAIR Principles[2] stand for Findability, Accessibility, Interoperability, and Re-use of digital assets, providing a set of guidelines for scientific data management and stewardship. This issue is more related to Open Science processes, so it is worth checking the guidelines with both educators and researchers in your institution.

[2] See Wilkinson et al. (2016). https://www.nature.com/articles/sdata201618

Foster portal

The FOSTER portal is an e-learning platform that brings together the best training resources addressed to those who need to know more about Open Science, or need to develop strategies and skills for implementing Open Science practices in their daily workflows.[3]

Figure 8. A screenshot of the Foster portal website (https://www.fosteropenscience.eu/).

[3] The description of the Foster portal is retrieved from: https://www.fosteropenscience.eu/

TIP

Utilise open database and open-source repository

Open Data is a great tool to let pupils learn and experience authentic scientific processes. A teacher or students themselves can choose suitable datasets and re-use them for their own research projects and learning activity.

The example cases of integrating Open Data in teaching practice can be found in The Hagen Cumulative Science Project (Jekel et al., 2020) and HDip Irish Folklore by UCD School of Irish. Also, utilising Open Source can give students a better understanding of real-world projects and insights into the impact of OS (e.g., Geo Python course by the University of Helsinki).

Useful links

Open Data

- EOSC Portal (European Open Science Cloud)
- data.europa.eu (European official data portal)
- OSF (Free open platform to search paper, data and materials)
- World Bank Open Data (Open global development data)
- WHO Global Health Observatory (Open world health data)

Open Source

- GitHub (Collaborative development platform and Open Source repository)

3

Implementation phase

STEP 3-1: Introduce a Learning Design Framework

The INOS Project aims to enhance the impact of OS-integrated learning activities by offering pedagogical support to HEIs and other educational organisers. With the aim, the consortium developed a Learning Design Framework (LDF). The LDF helps organisers design a learning activity that incorporates OS/CS/OI elements and implements and improves the activity. It also facilitates reflecting on the United Nations' 17 Sustainable Development Goals[4] while planning the learning activity.

How does the Learning Design Framework work?

The framework consists of four steps: Goal setting, Activity development, Run Activity, Reflection and Future Planning.

It is designed as a reiterative process suggesting organisers check the current phase and go back to the previous step at any point to refine the plan.

The detailed instructions can be found in O2A3 Learning Design Framework.

[4] See https://sdgs.un.org/goals

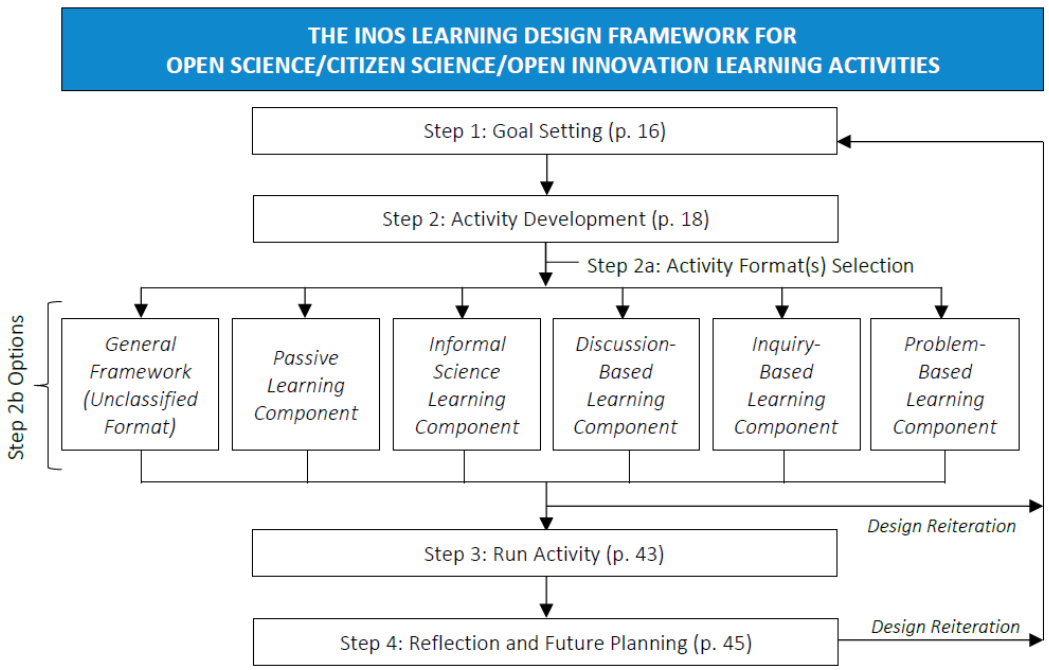


Figure 9. Overview of the Learning Design Framework for OS/CS/OI Learning Activities. Retrieved from Teo (2020b).

In step 2, organisers decide on the learning activity format and select an appropriate planning sheet. The suggested learning methods are selected based on the pedagogical effectiveness, and the characteristics of OS activities studied in our previous research[5].

The LDF provides separate planning sheets for each learning method to cover different structures and characteristics such as level of participant engagement and task complexity (see figure 9 below).

[5] Teo, E. A. (2020a). State-of-the-art analysis of the pedagogical underpinnings in open science, citizen science and open innovation activities. E. Triantafyllou (Ed.). INOS Consortium. Retrieved from https://inosproject.eu/

There is also a planning sheet for an unclassified learning activity so that organisers can flexibly design different types of activities on their own. A detailed description of each learning method is found in the next section.

What kind of learning methods are used?

How are these learning methods different from each other? What are the tasks and goals? What learning outcomes are expected? What kind of activities could be examples of each method? If you want to know more about these learning methods, you can find the summary table in the Learning Design Framework (see p.11-12) or other deliverables of the INOS project (visit https://inos-project.eu/).

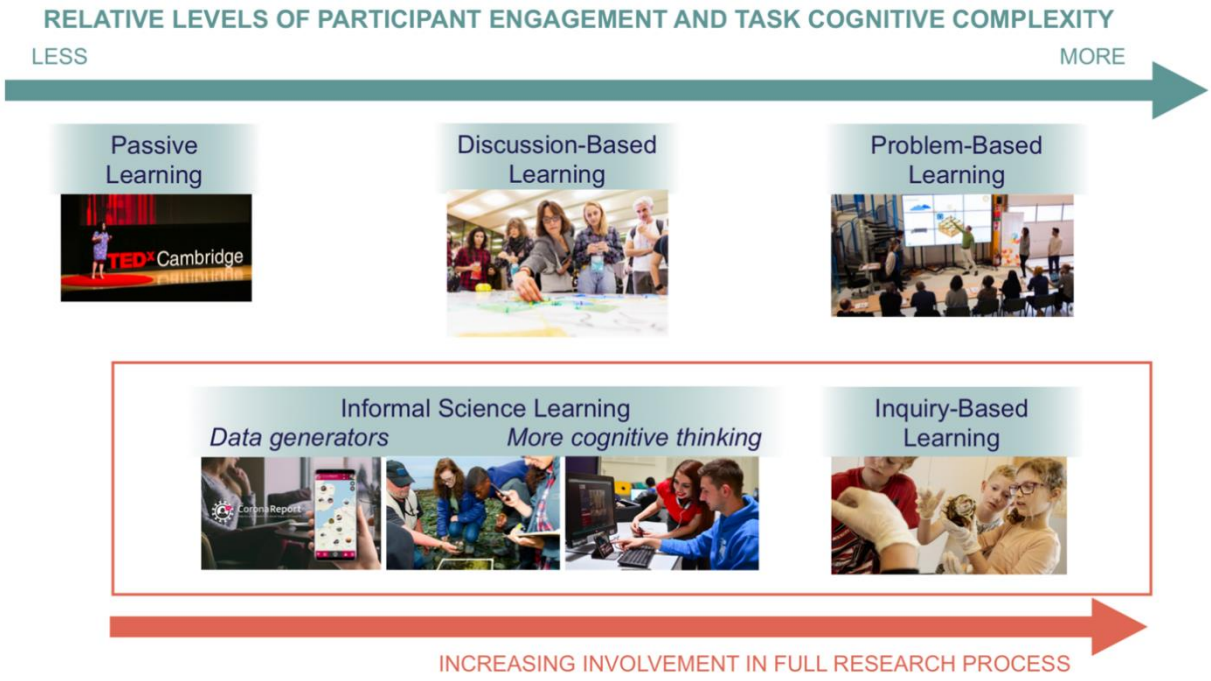


Figure 10. A comparison of the relative levels of participant engagement and task cognitive complexity between different OS/CS/OI Learning Activity Formats. The INOS Learning Design Framework encourages higher levels of participant engagement and task cognitive complexity, in order to enhance learning outcomes. Retrieved from Teo (2020b).

STEP 3-2: Develop your learning activity

After getting familiar with OS concepts and LDF, the next step is to design your own OS-integrated learning activity! You can create a concrete plan by following the steps in Learning Design Framework (the planning sheet starts on p.16).

1. Goal setting

Let's start with Goal Setting (see LDF p.16). Through your learning activity, what do you expect students to learn? What kind of skills do you want to develop in students? What is the topic or discipline of your learning activity? In what format is the activity carried out? You can consider these essential questions by following the structure of LDF.

TIP

Besides the subject-based learning goals, engaging students in OS activities is an important aim of the OS-integrated curricula. For instance, let students participate in collecting and using Open Data and creating OER as their final presentation could be good learning objectives.

2. Activity Development

The next step is Activity Development (see LDF p.19). It is recommended to use appropriate planning sheets depending on the selected learning method. There are five suggested learning methods: Passive Learning, Informal Science Learning, Discussion-Based Learning, Inquiry-Based Learning and Problem-Based Learning.

TIP

You can also combine some methods to design a whole learning module. For example, the first phase to cultivate domain knowledge can be designed with a Passive Learning method and the second phase to activate the acquired knowledge can be designed with a Discussion-Based Learning method.

1. Passive Learning Activities

Description: Presentation-style learning activities with participants as the audience

Application: This style is often used for basic training to acquire subject knowledge. The example application is a set of lectures about open access and data management for PhD researchers.

Pros: A teacher can transmit the knowledge to many students. The classroom facilitation is relatively easy.

Cons: Learning can be one-way because of a lack of interaction between teacher and students and among students.

2. Informal Science Learning Activities

Description: Participants are involved in certain stages of an existing research project led by experts/organisers (e.g., data collection, data analysis etc.)

Application: Informal science learning often occurs in CS projects in which students naturally learn a certain science topic through participation.

Pros: It works well to raise awareness of certain phenomena or provoke interest in new topics. Students feel less stressed and maintain their curiosity because this casual learning mode typically requires no assignment.

Cons: Teachers cannot assess the learning outcomes of students; thus, it is difficult to incorporate this learning approach into the official curriculum.

3. Discussion-Based Learning Activities

Description: Participants are placed in groups to discuss a topic and produce a collaborative artefact that demonstrates their learning.

Application: This approach can be used both in CS- and OI-oriented learning activities. The discussion can include, for example, researchers and professionals of a certain field or business stakeholders related to the innovation.

Pros: Students can exchange their ideas, add other perspectives on top of their own understanding and update the knowledge or build new knowledge as a team.

Cons: Discussion might not be facilitated if students hesitate to speak out or stick to their own ideas and do not accept other ideas.

4. Inquiry-Based Learning Activities

Description: Participants conduct a research project using the scientific inquiry method

Application: It is often applied in long-term learning activities such as a course taking several months or a degree program (especially master's level)

Pros: Students can seek their own research questions and experience authentic scientific inquiry processes and practical procedures, which can promote deep understanding on the phenomena.

Cons: It requires a teacher's sufficient skills and experiences to guide students in scientific inquiry process. The student engagement and self-regulation is a key to successful learning outcomes, thereby teacher intervention may be difficult.

5. Problem-Based Learning Activities (incl. Project-Based Learning and Challenge-Based Learning)

Description: Cross-border groups of participants innovate a solution for a problem

Application: This method is often used in OI activities (e.g. hackathon), including various types of participants.

Pros: It can enhance student engagement with the power of team learning and cultivate self-directed organising skills. An innovative idea can be generated by a team's synergy, including participants from various backgrounds and cultures.

Cons: If the given problem is irrelevant (e.g., students' prior knowledge cannot be activated) or inappropriate (e.g., too difficult or requires advanced skills), student learning outcomes would be superficial. Students with introverted personalities may find it challenging to communicate with other peers.

3. Run activity

Setting a pre-learning activity such as orientation or pre-training is highly recommended. It is usually meant for giving students prerequisite knowledge or training to familiarise themselves with a certain digital tool or methodology, or sometimes icebreaker activities to get to know each other. Such pre-learning activity takes an important role, especially if the learning approach is highly collaborative. It can minimise the students' knowledge and skill gaps by providing essential information and instructions. Students can also promote mutual understanding and the task, strengthening group cohesion.

TIP

Think about the following points when designing a pre-learning activity.

- Do the participants have sufficient backgrounds to complete the learning tasks?
- Is there any specific prerequisite knowledge or background information to be transmitted to students?
- Does the learning activity employ any digital tools or methods which might not be familiar to some students?
- Are all the resources (e.g., learning materials, data, digital tools etc.) accessible to all the participants?

4. Reflection and Future Planning

The details are presented in the final section (see p.30).

STEP 3-3: Upskill with digital tools

Nowadays, digital competencies are prerequisites for both students and teachers. Active learning can be facilitated by technology enhancing student engagement and collaboration. Especially, OS is supported by various digital environments with open access in which people can freely get resources, upload materials or connect to others. Thus, upskilling teachers with useful digital tools is essential to designing and conducting OS-integrated learning activities. In this section, we will introduce some useful digital tools used in the INOS Open Knowledge Activities and Open Innovation Activities.

Discussion board

A Discussion board is useful for brainstorming and ideation as it visualises participants' thoughts and relationships between the elements. It also allows participants to work simultaneously, enhancing active interactions among them. Example tools are very intuitive and simple enough for first-time users because it just has essential, basic functionalities such as putting sticky notes, connecting elements or inserting links and pictures.

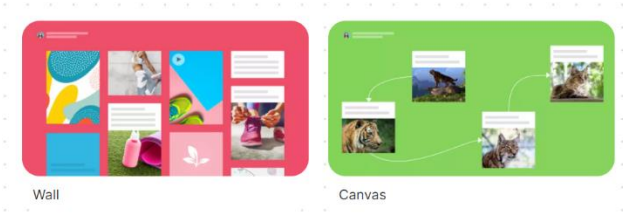


Figure 11. A screenshot of the Padlet website (https://padlet.com/).

Useful tools

Padlet, Miro board, Flinga, Google Jamboard

Interactive teaching tools

Some activities used interactive teaching tools to facilitate student engagement. Word cloud generator is good for the icebreaker session and initial stage of learning a new topic. You can create interactive learning materials that can embed videos, pictures, texts, and a quiz and comment box. Quiz applications can facilitate the students' active engagement by allowing them to join the activity simultaneously and compete with each other.

Figure 12. A screenshot of the Mentimeter website (https://www.mentimeter.com/features/word-cloud).

Useful tools

Word cloud: Mentimeter, AnswerGarden

Interactive materials: Sutori, WordPress,

Quiz application: Quizlet, Kahoot!

Collaboration platform

A collaboration platform is a virtual environment for online collaboration. Recently, its demand has dramatically increased due to the Covid-19 pandemic, and quite many people are already competent in using such tools. One collaboration tool is equipped with necessary functionalities for team working, such as chat and video calls, sharing the material, and scheduling a meeting. However, license issues could be an obstacle if the collaboration is across different organisations. In this case, you can utilise free communication and video conference tools such as Zoom, Skype or WhatsApp and also create your own project portal on the website.

Useful tools

Microsoft Teams, Google drive and classroom, Slack

Collaboration canvas

It covers most things you can do with the abovementioned discussion board but provides a wider range of functionalities with higher flexibility. The merit of this canvas is that the participants can do necessary things in one place.

For example, a platform that embeds a video chat function can allow the participants to visualise discussion on the board with communicating simultaneously. You can also create a poll or question box on the board and ask the participants' opinions timely. Some tools provide ready-made templates for brainstorming, team building or problem-solving that allows saving time for collaboration.

Useful tools

Klaxoon, Trello, MURAL

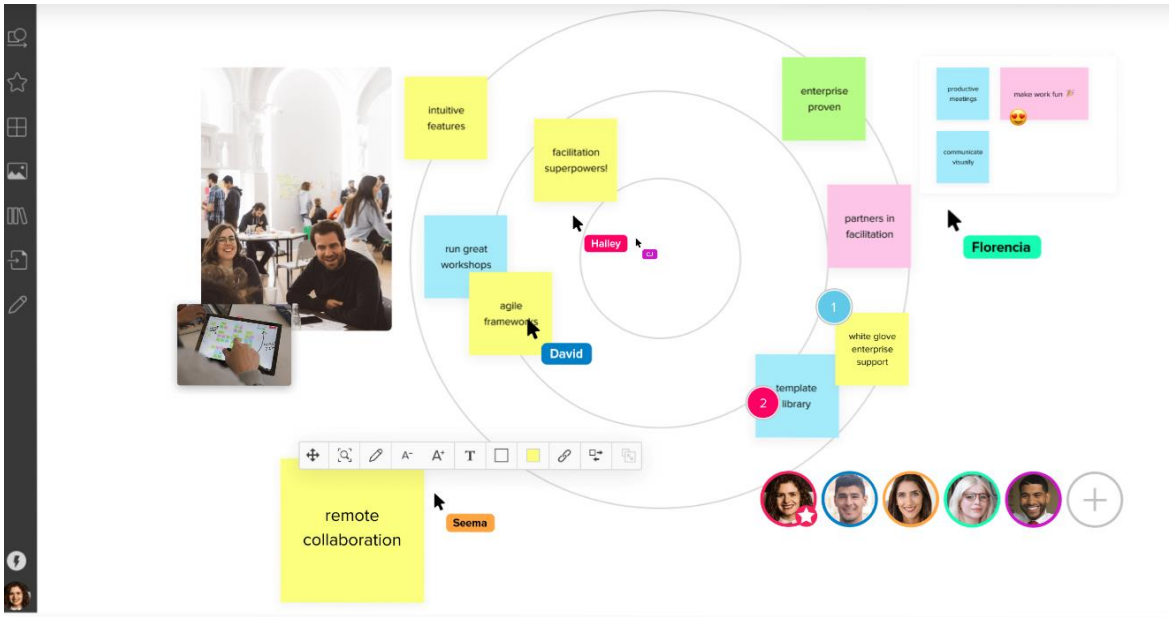


Figure 13. A screenshot of the MURAL website (https://www.mural.co).

4 Follow-up phase

STEP 4-1: Reflect on the learning activity

Finally, this is the last section of the training, meaning that you have gone through all the necessary activities! It's time to reflect on your accomplishment. How did you feel about designing and implementing an OS-oriented learning activity? Was it challenging? Did you find the value and potential?

Our LDF can help your reflection by offering a checklist (p.45-46) and a strength-challenge finder matrix (p.47).

Effective reflection includes both thorough individual reflection and active discussion with people. Thus, we recommend you ask each teacher (or learning activity organiser) fill the LDF checklist and matrix first before having a group reflection. Although a group of teachers designed a learning activity, it is important to have a separate individual reflection time. After self-reflection, prepare a joint discussion place and let the teachers exchange their own perspectives on their reflections.

STEP 4-2: Revise and re-plan

Let's have a close look at the challenges and break it down to improve the activity for the next round! What were the main constrains? What were you missing? You may have had the following issues:

Technical issues

- ✓ Digital environment (tool) was unstable / expensive / complicated
- ✓ License and access right issue

Resource issues

- ✓ Learning material was insufficient / expensive / inaccessible
- ✓ Difficult to recruit external stakeholders / citizens / collaboration partners

Competence issues

- ✓ Teachers had difficulty in facilitation / technology use / coordination
- ✓ Students had difficulty in understanding the concept / technology use / group work

Pedagogical issues

- ✓ Difficult to engage the student in the activity
- ✓ Difficult to teach domain-specific knowledge
- ✓ Difficult to assess learning outcomes

Cultivate OS culture with a community

> ***"For universities and other stakeholders to embrace Open Science principles, policies and practices, there needs to be a culture change in these organisations if this transition is to be successfully negotiated"***
>
> ***League of European Research Universities, 2018. p3***

Cultivating an 'open culture' within an institution is crucial to fulfilling the vision of OS implementation at an institutional, practical level. The shared culture connects people with strong bonds, allows them to share goals, changes their mindset and attitudes, and improves their practices. To cultivate an open culture among HE educators and other academic staff members, we would like to emphasise the power of 'community.'

Community of Practice - a group of common interests and visions

Community of Practice (CoP) (Lave & Wenger, 1991) is defined as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger, 2011, p. 1). It was originally a theory of social learning by Lave and Wenger (1991) that explains how beginners can learn new knowledge and skills from experts but has widened its application to business sectors to improve the performance of groups (Li et al., 2009). In CoP, people share a domain of interest, organise and engage in joint activities and provide support and information to each other (Wenger, 2011).

To train your institution's teachers and researchers, we highly recommend creating an internal OS community connecting different faculties and departments. The following outcomes are expected through the community operations:

- Discussion about OS will increase across the institution
- Members can get updated with the latest information (e.g., national policy change)
- People with different expertise can share information and support each other
- Multidisciplinary communication will be facilitated
- Cross-faculty/department cooperation will be fostered
- Partnerships with external organisations will be encouraged

Open Science community in Europe

In the Netherlands, universities have their local Open Science communities. The first one, The Open Science Community Utrecht (OSCU), was founded in 2018. There are over ten Open Science Communities in the Netherlands, one in Ireland and one in Sweden.

The community comprises university students, researchers, educators and other staff members from all faculties and academic levels. The main job of an OS community is to disseminate the related information and hold training workshops and webinars to educate the members with OS philosophy, making opportunities to talk and learn about OS practices. They also provide professional advice and help on how to apply learned OS concepts in their research projects.

You can find Open Science Community Starter Kit from here: https://www.startyourosc.com/

"We believe that university staff are best suited to lead the path towards OS – those who put OS to practice. That is why local bottom-up Open Science Communities (OSCs) are crucial in this transition (see our white paper). OSCs can articulate the opportunities and obstacles that researchers and other staff experience while learning new skills and sharing knowledge"

Open Science Community in the Netherlands (https://www.osc-nl.com/)

Figure 14. The thirteen open science communities worldwide. Image by Anita Eerland, licensed under CC BY-ND 3.0. (Retrieved from https://osc-delft.github.io/).

Conclusion

What are the lessons learned?

This guidebook reiterated the importance of integrating OS and CS into pedagogical design, providing practical ideas to train educational staff in your institution. More specifically, it guided you to design OS training through four phases: preparation, training, implementation, and follow-up.

We have stressed the importance of forming a project team and analysing the current state of your institution to plan a long-term vision for OS/CS integration. Involving diverse people from different faculties and departments and building a sustainable learning structure and community were suggested to expand and extend the effect of the training.

Engaging teachers in real OS/CS activities was highly recommended. Such an experience allows them to learn the principles and mechanism of OS/CS by doing it themselves and helps them in designing future learning activities for their students. The importance of training for data handling and management was also emphasised, as OS is realised by open access to data, information, and resources.

In the implementation and evaluation phase, we introduced a Learning Design Framework as a foundation for designing and evaluating the activities. This framework allows for flexible planning by suggesting various useful teaching methods and resources.

Finally, we recommended forming an Open Science Community in your institution. Keeping a sustainable learning system after the training has ended is one of the biggest challenges in the implementation of OS/CS. This community of people with common interests – a Community of Practice – can solve this issue and help to cultivate OS initiatives across your institution!

Next step – developing OS-integrated curricula

Did you get insights in how to train HE educators with OS principles? We hope this guidebook provided you with new ideas and tips for educational development. Once teachers are ready to embrace the value of OS and to integrate the concept into their teaching, it is a good time to review and revise the current curricula of your institution.

Our next report: Recommendations on integrating OS (and CS) in HE curricula (download from: https://inos-project.eu/) will consider how to develop official curricula that incorporates OS principles from both an administrative and didactic perspective — so stay tuned!

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INTEGRATING OPEN AND CITIZEN SCIENCE INTO ACTIVE LEARNING APPROACHES IN HIGHER EDUCATION

https://inos-project.eu