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

Enhancing impact using pedagogy: A roadmap for organising open science, citizen science and open innovation activities

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Abstract:	The document corresponds to O2A2 of the INOS Project. The INOS Project aims to enhance the impact of OS/CS/OI activities by offering pedagogical support to HEIs and other activity organisers. This roadmap provides organisers with recommended actions to implement and advance pedagogical practice in OS/CS/OI activities. Recommendations are provided for each stage of the Teaching Cycle:

1) design and plan, 2) engage with students, 3) reflection, and 4) professional development.

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Consortium

	Name	Short Name	Country
1	Aalborg University	AAU	Denmark
2	Tallinn University	TU	Estonia
3	Web2Learn	W2L	Greece
4	University of Oulu	UO	Finland
5	University of Bordeaux	UBx	France
6	STICHTING LIBER	LIBER	The Netherlands

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List of Abbreviations

The following table presents the acronyms used in the deliverable in alphabetical order.

Abbreviations	Description
CS	Citizen science
HEI	Higher education institutes, including academic libraries
OS	Open science
OI	Open innovation

Executive Summary

Open science (OS), citizen science (CS) and open innovation (OI) improve the quality of scientific and innovation outputs. They also promote public engagement with science and technology, openness and active citizenship. Higher education institutes (HEIs) are increasingly involved with organising such activities, which include hackathons, datathons, service jams, knowledge cafés, fablabs, game labs and innovation sprints.

Many OS/CS/OI activities involve some form of learning or knowledge transfer. Often, such activities are used to improve skills and public knowledge on important topics. Learning also occurs when stakeholders of different backgrounds collaborate on a project and need to acquire new technical and soft skills to facilitate the collaboration. OS/CS/OI products, such as open data, open software and open hardware are often used as learning tools and resources in these learning activities.

Therefore, learning is critical to OS/CS/OI activities. It is argued that the overall educational, scientific, innovative and social impact of these activities would be optimised if the learning components were grounded in solid pedagogy. Currently, there is the opportunity to expand and improve the HEI curricula of OS/CS/OI activities.

The INOS Project aims to enhance the impact of OS/CS/OI activities by offering pedagogical support to HEIs and other organisers of relevant activities. This roadmap provides organisers with recommended actions to implement and advance pedagogical practice in OS/CS/OI activities. Recommendations are provided for each stage of the Teaching Cycle: 1) design and plan, 2) engage with students, 3) reflection, and 4) professional development. Key recommendations include:

- Establishing a learning design process.
- Specifying learning goals and objectives.
- The collection of success metrics and learner responses for reiterative learning design and improvement.
- Documentation of pedagogical information for future reference and improvement.
- Pedagogical discussion of OS/CS/OI activities enables the sharing and advancement of knowledge.

This roadmap targets HEIs and libraries (staff, researchers and students) wishing to enhance the educational, scientific, innovation and social impact of their OS/CS/OI activities. This roadmap is also of interest to independent initiatives organising such activities.

1. Introduction

1.1 What are open science, citizen science and open innovation activities?

Open science (OS), citizen science (CS) and open innovation (OI) all share common characteristics of cross-border interaction. Their activities are transparent, accessible, shareable and open to participation. In all cases, science and innovation work is expanded beyond the "conventional" group of participants across fields, sectors, communities and cultures. Other stakeholders, particularly those with experience in fields other than academia and science (i.e. "citizens"), are welcome to observe, share and collaborate.

> *"**Open Science** is the practice of science in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods"* – FOSTER (FOSTER, n.d.).

> *"**Citizen Science** refers to the general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources"* – White Paper for Citizen Science for Europe (Fermín Serrano Sanz, Holocher-Ertl, Kieslinger, García, & Silva, 2014).

> *"**Open innovation** occurs where knowledge flows beyond the boundaries of a single organization and where a high degree of cross-border organizational collaborations take place… end-users, policy makers, industry and academic institutions work together to advance scientific knowledge or to develop new solutions and prototypes"* - Knowledge translation mechanisms in open innovation: The role of design in R&D projects (Simeone, Secundo, & Schiuma, 2017).

Open practice improves the quality of scientific and innovation outputs, especially in the face of solving complex multidimensional issues such as climate change (Hautamäki & Oksanen, 2016). Such novel solutions and prototypes are only possible via cross-border collaborations. OS/CS/OI also promote public engagement with science and technology, openness and active citizenship. As formal settings of research and innovation, higher education institutes (HEIs, including academic libraries) are increasingly involved in organising such open activities and expanding their collaborative networks (Figure 1.1, Figure 1.2 and Figure 1.3).

Figure 1.1 – The Fablab Coh@bit at the University of Bordeaux is a space to collaborate, create and prototype innovative products. Facilities include 3D printing, Arduino (open source electronics hardware and software), and laser engraving. The fablab hosts activities for university students, young school students, private companies and the general public. Photos courtesy of Antoine Blanchard.

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Figure 1.3 – A citizen science activity hosted by Tallinn University. School teachers test out an environmental sensor (by [Labdisc Enviro](#)). These sensors are to be used by school students to measure the urban heat island effect of the city. Photos courtesy of Kai Pata.

1.2 Why is learning important to OS/CS/OI activities?

Many OS/CS/OI activities involve some form of learning or knowledge transfer. Often, activities are used to improve skills and public knowledge on important topics. For example, many citizen science activities are designed to advocate for environmental awareness or other contemporary causes. Events such as hackathons, datathons, service jams, knowledge cafés, fablabs, game labs and innovation sprints are also commonly held to improve public literacy on important 21st Century skills in science, technology, engineering and innovation.

Learning also occurs when stakeholders of different backgrounds collaborate on a project. Participants need to acquire new technical and soft skills to facilitate the collaboration. For instance, when citizens or school children participate in or conduct their own scientific research, they need to first understand the scientific inquiry process and acquire relevant technical skills (such as data collection methods, and data analysis tools and software). In another scenario, when a multidisciplinary group of researchers is collaborating with non-university-based members to innovate a new product, all stakeholders need to practice collaborative soft skills (such as teamwork, communication, problem-solving), and to be familiar with each other's backgrounds in order to navigate the project.

OS/CS/OI products, such as open data, open software and open hardware are often used as learning tools and resources in these learning activities.

Therefore, learning is critical to OS/CS/OI activities. The INOS Project proposes that the overall educational, scientific, innovative and social impact of these activities would be optimised if the learning components were grounded in solid pedagogy. Currently, there is the opportunity to expand and improve the HEI curricula of OS/CS/OI activities.

The INOS Project aims to enhance the impact of OS/CS/OI activities by offering pedagogical support to HEIs and other activity organisers. This roadmap provides organisers with recommended actions to implement and advance pedagogical practice in OS/CS/OI activities.

1.3 Introduction to learning design

*"A '**learning design**' is defined as the description of the teaching-learning process that takes place in a unit of learning (eg, a course, a lesson or any other designed learning event). The key principle in learning design is that it represents the learning activities and the support activities that are performed by different persons (learners, teachers) in the context of a unit of learning"* – Current Research in Learning Design (Koper, 2006).

When designing a learning activity, there are various pedagogical decisions to be made, from pedagogical theories to implementation tools and resources. Instructional design models offer frameworks for educators to incorporate these pedagogical elements. A common and comprehensive framework for instructional/learning design is the Larnaca Declaration for Learning Design (Dalziel et al., 2016). The framework is centred around a Teaching Cycle, which includes stages of Design and Plan, Engage with Students, Reflection, and Professional Development. The recommendations of this roadmap are organised by these stages of the Teaching Cycle.

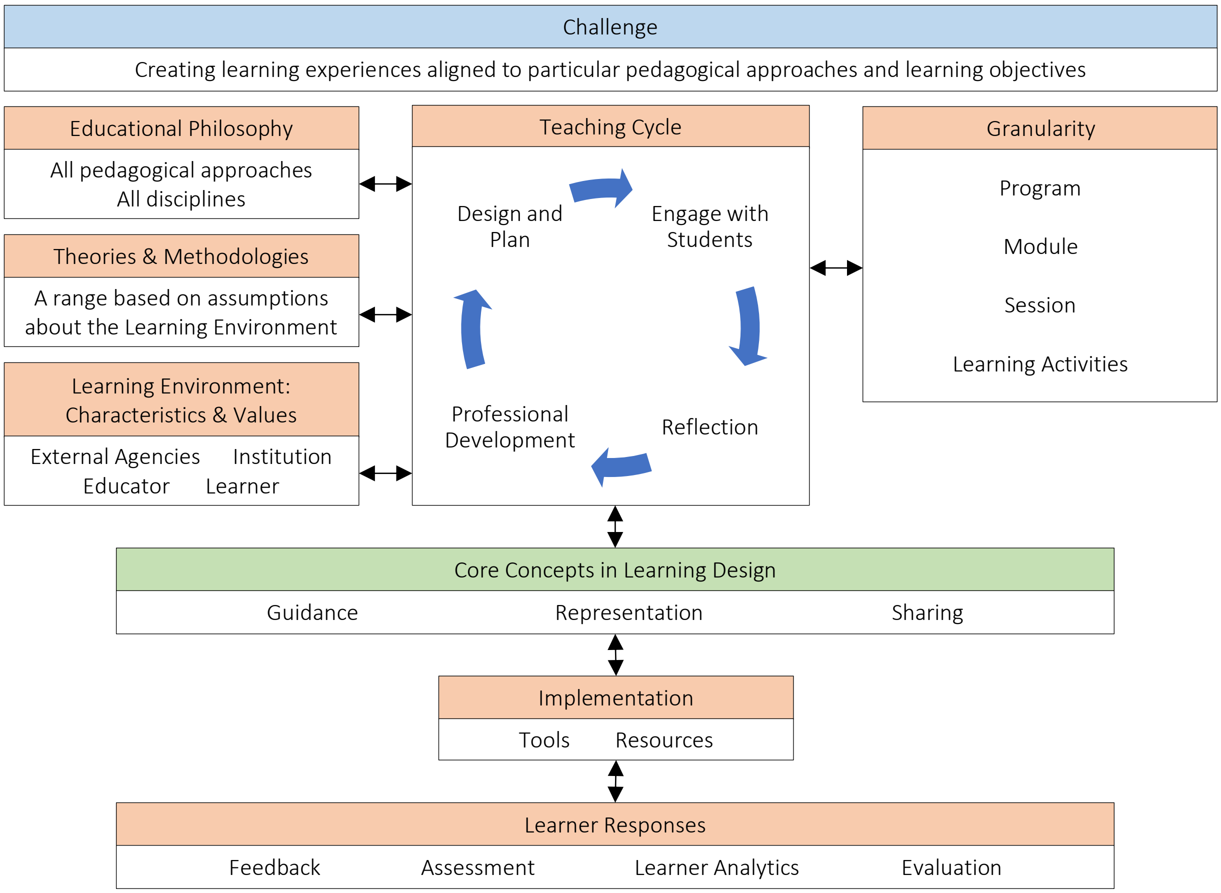

Figure 1.4 – The Learning Design Conceptual Map of the Larnaca Declaration of Learning Design (reproduced from Dalziel et al., 2016). The arrows indicate how different pedagogical elements interact.

1.4 Current landscape of learning design in OS/CS/OI activities

This roadmap is based on [a state-of-the-art analysis on the pedagogy of recent OS/CS/OI activities] (Teo, 2020). Key findings of the analysis are summarised here.

Learning goals

Motivations behind OS/CS/OI activities include broader aspirations of improved inclusivity in science/innovation activities, improved social relevance of science/innovation outputs, improved relationships between citizens and HEIs, improved awareness of causes, and the empowerment of citizens with knowledge to encourage fact-based societal change. While a diverse range of topics is covered by OS/CS/OI activities (e.g. coding, ecology, sustainability design, demographics, civil monitoring etc.), there are several recurring types of learning goals, including:

1. Increased knowledge or awareness of a specialised topic.

2. Attainment of soft and technical skills needed for OS/OI practice.
3. Increased knowledge of the scientific inquiry method.
4. Improved open data skills.

Learning approaches

These learning goals are delivered in a variety of ways. The following are examples of popular approaches with benefits for OS/CS/OI activities.

Table 1.1 – Popular learning approaches, their generalised learning sequence, and their benefits for OS/CS/OI activities.

Learning approach	Generalised learning sequence	Benefit
Project-based learning	• Participants are given a broad task brief. • Participants perform their own background research to identify a real-world issue they wish to solve. • Participants work in multidisciplinary teams. • Participants generate multiple ideas and test them. • Participants fine-tune their ideas and produce a final output. • Participants present their project.	Good for developing innovation/collaboration skills, which are important for open practice in science and innovation.
Inquiry-based learning	• Participants are provided background information on a certain topic, or are allowed to explore a topic of their own interest. • Participants are given or are asked to identify a research question. • Participants are given or are asked to design a methodology to address the research question. • Participants gather evidence and analyse it to respond to the research question. • Participants share their findings. • Mentors provide guidance to participants to assist in their progress.	Good for demonstrating the scientific inquiry process and teaching scientific content.
Collaborative learning	• Participants are asked to examine and to discuss an issue together. • Used to complement project-based and inquiry-based learning activities. • Learner-centred approach with intense interaction between participants.	Conducive for creative thinking and open-ended learning, which are emphasised in open educational practices, and are important to develop soft collaborative skills in open science/innovation.

Learning approach	Generalised learning sequence	Benefit
Blended learning	• Participants learn from a combination of online and classroom teaching methods. • Participants are asked to exploring information via online MOOCs or other online resources before commencing the activity. • Used to complement project-based and inquiry-based learning activities. • Online games may also be used to complement classroom teaching activities.	A combination of online and classroom tasks enables effective use of available open resources. OS/CS/OI activities often utilise open access resources available online (e.g. open data, open software/hardware, open educational resources).

Project-based learning, inquiry-based learning, collaborative learning and blended learning are all examples of formal learning (i.e. planned learning). Formal learning occurs when an activity has specified learning goals and objectives, and the activity is designed so that it intentionally facilitates the learning of said goals and objectives.

However, not all OS/CS/OI activities utilise a formal learning approach. It is also common for activities to adopt informal learning (i.e. learning by participation). In informal learning activities, learning goals and objectives are not specified, and so the activity is not designed with them in mind. In other words, learning as an output depends on the participants' own motivation and initiative. A key example are CS activities that crowdsource data collection – these activities may be designed primarily to ensure the quality of data collected, and whether participants learn from such events is dependent on the participants own volition.

Table 1.2 – The differences between formal and informal learning, as considered by the INOS Project.

Formal learning	Informal learning
• Specified learning goals and objectives. • Activity is designed so that it intentionally facilitates the learning of said goals and objectives. • Learning is an intentional output, thus occurring with more certainty.	• No specified learning goals and objectives. • Activity is not designed to achieve specific learning goals and objectives. • Learning as an output is uncertain, as it is entirely dependent on the participants' own motivation and initiative.

Informal learning has indeed been found successful in some cases, such as by increasing awareness of local community issues and to improve understanding of the scientific inquiry process (Crall et al., 2012; Cronje, Rohlinger, Crall, & Newman, 2011; Jenkins, 2011; Phillips, Ballard, Lewenstein, & Bonney, 2019; Trumbull, Bonney, Bascom, & Cabral, 2000; Villasclaras Fernandez, Sharples, Kelley, & Scanlon, 2013). However, informal learning produces inconsistent results. Many studies also show that participation alone is not sufficient to ensure learning, as seen by insignificant knowledge gain in activities where pedagogy was not explicitly considered (Groulx, Brisbois, Lemieux, Winegardner, & Fishback, 2017; Jordan, Gray, Howe, Brooks, & Ehrenfeld, 2011; Land-Zandstra, Devilee, Snik, Buurmeijer, & Van Den Broek, 2016; Martin, 2017; Pandya & Dibner, 2019; Phillips et al., 2019; Powell & Colin, 2008; Raddick, Prather, & Wallace, 2019). For example, without explicit learning goals and objectives, participants may be confused about the purpose of the activity (Evans et al., 2005).

If learning is a desired product of the activity, formal learning design delivers this goal with better certainty. For example, it is possible to embed participation in CS activities into an inquiry-based learning format, because data collection (a common form of CS activity) is one of the phases of the scientific inquiry process.

Participants

OS/CS/OI activities attract a diverse range of participants, from librarians, students and researchers, to the general public and specific communities. Activities can be conducted for these groups separately or together, depending on the learning goals. For example, some activities encourage and upskill collaboration between researchers and the general public – in these cases, both communities may be involved. Other activities may focus on upskilling a specific target audience.

Participants are sometimes given agency to be part of the learning design themselves, due to the emphasis on creating activities that are socially needed and relevant. For example, in many project-based activities, participants are given a broad task brief, are tasked to independently ideate a project and to decide the skills necessary to complete it. However, the role of participants in the learning design can be made more significant.

Learning settings, tools and resources

In terms of time, activities can be conducted within a day (e.g. short projects integrated into a school or university lesson), or as longer projects requiring a few days to a few weeks to complete (e.g. activities involving the collection of data over extended periods). OS/CS/OI courses can take anywhere from a month to six months to complete.

Learning is conducted in many different spaces, such as classrooms, outdoors, public spaces, personal homes, collaboration/innovation facilities, and virtually (online, computer-based and/or mobile phone-based). Many CS activities, especially those with natural science topics, are conducted outdoors and in public spaces so that participants can explore and collect data. Activities that focus on collaboration and innovation provide dedicated collaboration/innovation facilities, such as prototyping areas (e.g. fablabs, makerspaces), as well as spaces for participants to discuss ideas (e.g. meeting rooms).

Online and computer-based learning settings are also popular ways of delivering online resources, including learning material (e.g. educational resources, videos and games) and learning tools (e.g. open data and open software). Mobile phones are also often used as an easy tool to collect data for outdoors-based CS activities.

Overall adoption of learning design

Pedagogical information related to OS/CS/OI activities is generally limited. Methodical learning design appears to be conducted inconsistently, or is not documented and made public, despite its pedagogical advancement value. In the case of CS activities, this may be due to the dominant reliance on informal learning (i.e. learning by participation), which lacks planned pedagogy. Another reason may be the lack of incentive for conducting full learning design for “one-off” standalone OS/CS/OI events.

1.5 Implications for roadmap

Based on the current landscape, there are several considerations when determining the next steps:

- There is value in implementing learning design for OS/CS/OI activities, including standalone, “one-off” events. Awareness of this can be improved.
- Upskilling HEI and library staff, along with students and researchers, on pedagogical practices would be useful for developing educational OS/CS/OI activities.
- Informal learning in CS activities produces inconsistent learning results.
- Learning design, including learner responses, needs to be documented and shared to advance the pedagogy of OS/CS/OI activities.
- A knowledge pool and community of learning design for OS/CS/OI activities is necessary to share and consolidate ideas.
- OS/CS/OI activities are often learner-centred. In other words, participants take an active and responsible role in their learning, as activities commonly involve independent or team-based problem-solving exercises. Participants respond well to expert guidance during learner-centred activities.
- There is the potential to engage participants more in learning design.

2. Roadmap

This section presents the recommended ways for OS/CS/OI organisers to implement and advance pedagogical practice in OS/CS/OI activities. The recommended actions are organised by the stages of the Teaching Cycle according to the Larnaca Declaration for Learning Design (Dalziel et al., 2016). These actions should be repeated with every iteration of the activity, as described by the cyclical nature of the Teaching Cycle (Figure 2.1).

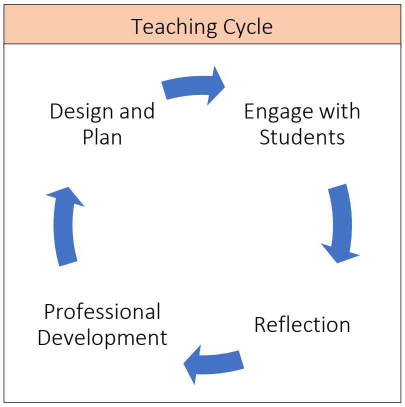

Figure 2.1 – The Teaching Cycle of the Larnaca Declaration of Learning Design (full conceptual framework available in Figure 1.4).

2.1 Design and plan

This stage involves the preparatory work an educator conducts before the course is implemented. Designing includes establishing the learning goals, learning objectives, and learner response metrics. Planning includes the creation of specific activities and tasks in concordance to the goals, objectives and learner response metrics.

Table 2.1 – Challenges and opportunities, and recommended actions within the Design and Plan stage.

Challenges and opportunities	Recommendations for organisers
Many OS/CS/OI activities do not sufficiently design the learning component of their activities.	• Adopt an instructional design model (e.g. the Larnaca Declaration for Learning Design) as a framework to design the learning component of the OS/CS/OI activity. • Establish specific learning goals and objectives. • Develop activities and tasks that are designed to achieve said learning goals and objectives. ○ Adopt suitable learning approaches. Project-based learning, inquiry-based learning, collaborative learning and blended learning have been found to be beneficial for OS/CS/OI activities (see Section 1.4). • Establish suitable success metrics to determine if learning goals and objectives are met. The collection of learner responses can take the form of feedback, assessments, learner analytics and evaluations (see Section 2.3 for further details).

<table>
<tr><th>Challenges and opportunities</th><th>Recommendations for organisers</th></tr>
<tr><td>Many OS/CS/OI activities adopt informal learning as their teaching strategy. However, informal learning produces inconsistent learning outcomes.</td><td>Adopt a formal learning approach. For example, in the case of CS activities, a natural method to do so is to embed participation in CS activities into an inquiry-based learning format, because data collection (a common form of a CS activity) is one of the phases of the scientific inquiry process. For example, see Learning through Citizen Science: Enhancing Opportunities by Design (Pandya & Dibner, 2019).</td></tr>
<tr><td>The experiences of past iterations of OS/CS/OI activities (or similar) provides valuable input on planning and designing an activity.</td><td>Refer to learning designs and learner responses of former iterations of the activity. Identify the strengths and weaknesses of these former approaches and incorporate these findings into your activity design.
If pedagogical information of former iterations are limited or unavailable, research the pedagogies of similar activities conducted by others (e.g. see the case studies described in Teo, 2020). Such information may be sourced from:
Pedagogical publications
Activity websites (which may also include open educational resources such as lesson plans that can be reused and adapted)
Informal discussions with other organisers of similar activities.
Ensure that the current iteration of the activity enables success metrics that can be documented and analysed for future iterations of the activity. Success metrics need to be reviewed with each iteration of the activity depending on the outcomes of the past event. Even if the current activity is a standalone, “one-off” event, this information is still useful for future similar events or for organisers of other events.</td></tr>
<tr><td>Participant input is valuable for planning and designing an OS/CS/OI activity that is relevant to participant interests and needs.</td><td>Take participant input into account when planning and designing an activity.
Participant input can be sourced from:
Learner responses of past iterations of the activity.
Learner responses of similar activities organised by others.
Informal discussions with potential participants.
Involving potential participants to provide input during preparatory meetings.
Input from participants can include their pre-activity knowledge of the topic, specific topic interests, skills they are interested in improving, the amount of guidance they may require, and expected activity outcomes. The goal is to use participant input to develop an activity that is relevant, useful and interesting to the participants. Adjust the activity’s design to address this information.
Design a procedure to receive participant input before, during and after the activity.</td></tr>
</table>

Challenges and opportunities	Recommendations for organisers
Open access resources are useful for implementing OS/CS/OI activities.	• If relevant, incorporate open access resources to implement your activity. Examples include: o Open software o Open hardware o Open data o Open educational resources
Pedagogical documentation of OS/CS/OI activities for future reference is beneficial.	• Useful information to document include: o Learning goals and objectives o Learning approach o Learning sequence o Learning tools and resources o Participants' pre-activity knowledge o Participant input to activity design o Method for collecting learner responses

2.2 Engage with students

The Larnaca Teaching cycle emphasises the importance of engaging with learners during the event. This allows educators to receive learner responses in real-time, and to adapt their teaching and classroom dynamics accordingly to improve learner performance. This stage addresses the issue where the act of teaching may play out differently to how it was initially designed and planned. This stage is also important to OS/CS/OI activities, as these activities are often learner-centred (i.e. participants are actively responsible for carrying the activity out independently or in groups).

Table 2.2 – Challenges and opportunities, and recommended actions within the Engage with Students stage.

Challenges and opportunities	Recommendations for organisers
Participants require proper introduction and background information, so that they are familiar with the activity's sequence and relevance.	• At the start of the event, communicate the learning goals and objectives to the participants. • Provide participants with sufficient background information so that they are able to carry out the activity with confidence. • Ensure that participants are aware of the modes in which they are able to communicate with educators during the activity. • Ensure that participants are aware of all of the tools and resources available to them to execute the activity.

Challenges and opportunities	Recommendations for organisers
Receiving "in the moment" responses from learners allows educators to adapt the learning activity to improve learner performance.	• Ensure that expert guidance is available throughout the activity, so that participants may ask questions and provide feedback. In learner-centred learning activities, participants may learn more when offered some guidance by experts, especially participants outside of academia and science fields (Evans et al., 2005). • When interacting with participants, note their difficulties and challenges in executing the activity.
Some OS/CS/OI activities are conducted online, without the possibility of personal engagement with learners.	• Engagement between participants and experts can still be conducted online, such as via social media, online discussion forums, email, and other forms of online communication. • Learner analytics can be used to collect information on participant behaviour during the activity.
Pedagogical documentation of OS/CS/OI activities for future reference is beneficial.	• Useful information to document include: o Learner responses during and after the activity. o "In the moment" adaptations of the activity in response to participants' feedback during the activity. o Factors that facilitated or challenged learning during the activity, as observed by the educators and by the participants. o Participants' post-activity knowledge.

2.3 Reflection

Reflection on teaching – during and after the activity – is important for the revision and improvement of future learning design decisions. It is important to be able to reflect on the strengths and challenges of the learning design.

Reflection requires educators to receive indications of learners' progress, and to analyse its implications. Indicators of learner responses can take the form of feedback (e.g. real-time learner reactions, course surveys), assessments, learner analytics (recorded data of learner behaviour via software e.g. "What are the final quiz scores of learners who spent above average time in the discussion forum?"), and evaluation (i.e. learners provide feedback on the learning design itself).

Table 2.3 – Challenges and opportunities, and recommended actions within the Reflection stage.

Challenges and opportunities	Recommendations for organisers
Learner responses enable reflection on learning design.	• Gather all learner responses from before, during and after the activity. Analyse the information to assess the strengths and challenges of the activity's design in delivering its learning goals and objectives.

Challenges and opportunities	Recommendations for organisers
Pedagogical documentation of OS/CS/OI activities for future reference is beneficial.	• Consolidate all information into a single resource. If possible, share the information under open licenses, such as via the activity's website and/or an open access publication. • Information can also be shared via community forums, social media, repositories and community blogs related to OS/CS/OI.
Pedagogical discussion of OS/CS/OI activities enables the sharing and advancement of knowledge.	• Organise/participate in pedagogical discussions relevant to OS/CS/OI activities. This includes workshops, lectures and conferences on open knowledge, or discipline-specific events within which OS/CS/OI activities are common (e.g. environmental science, ecology, computer science, engineering). • With other activity organisers, discuss learning design strategies and learner outcomes. The aim is to share knowledge and to discuss ideas on how to advance the pedagogy of OS/CS/OI activities. • As a community, establish a set of best pedagogical practices. This may take the form of a working guide on pedagogical OS/CS/OI activities.

2.4 Professional development

The Professional Development stage extends from the Reflection stage, involving a more long-term view of progressing learning design quality. Actions include formal Professional Development courses and gaining personal experience in education. These recommendations naturally connect to the Design and Plan stage of the Teaching Cycle.

Table 2.4 – Challenges and opportunities, and recommended actions within the Professional Development stage.

Challenges and opportunities	Recommendations for organisers
Organisers may be unaware of the potential of pedagogy to enhance the educational, scientific, innovative and social impact of OS/CS/OI activities.	• Become familiar with the literature that describes the potential of pedagogy to enhance the educational, scientific, innovative and social impact of OS/CS/OI activities (e.g. see Teo, 2020). • Share personal experiences of organising pedagogical OS/CS/OI activities in workshops, lectures and conferences.

Challenges and opportunities	Recommendations for organisers
Organisers may not have the knowledge, skills and experience in implementing pedagogy in OS/CS/OI activities.	• Identify pedagogical knowledge gaps and attend appropriate training. • Attend teacher training, such as those offered at universities for professional development. • Join professional communities for teaching and training to share your knowledge and learn from the experience of others. • Open up pedagogical training activities to HEI students, such as graduate students, who also wish to organise OS/CS/OI activities. • Use available open educational resources, such as those produced by the INOS Project, to research and gain ideas of how to plan, design and implement an OS/CS/OI activity with a solid pedagogy. • Gain experience in implementing OS/CS/OI activities with pedagogical considerations.

3. Beyond the roadmap

The INOS Project aims to enhance the impact of OS/CS/OI activities by offering pedagogical support to HEIs and other activity organisers. As part of the project, this roadmap provides organisers with recommended actions to implement and advance pedagogical practice in OS/CS/OI activities.

The recommendations for this roadmap were developed from a state-of-the-art analysis of the pedagogical underpinnings of recent OS/CS/OI activities (Teo, 2020), as well as an analysis of the engagement of higher education in CS (Zourou, 2020) and the recommendations (Zourou & Tseliou, 2020). All documents are available on the INOS Project website.

Beyond this roadmap, a learning design framework for fostering the educational value of OS/CS/OI activities will be developed. The framework will provide additional guidance for the pedagogical actions of this roadmap. By mid-2020, the learning design framework will be openly available via the INOS Project website.

The learning design framework will be followed by pilot activities for implementing the framework, guidelines on how to run open knowledge and open innovation activities, and training activities for academic and library staff and students.

4. Additional resources and contact information

All finalised resources are openly available via the INOS Project website. Activity updates are published on our Twitter account (@INOSProject), Facebook account (INOSProject), and our email newsletter (sign up here). Queries may be sent to our email address (inos.project.eu@gmail.com).

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