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

The INOS Learning Design Framework:

Fostering the Educational Value of Open Science, Citizen Science and Open Innovation Activities

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Abstract:	The document corresponds to O2A3 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.
Keyword list:	Open knowledge; open science; citizen science; open innovation; pedagogy; learning design

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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
LDF	Learning design framework
OS	Open Science
OI	Open Innovation

Executive Summary

Open Science (OS), Citizen Science (CS) and Open Innovation (OI) are principles that promote decentralised, cross-border interaction in research and innovation. Openness is exponentially transitioning towards the mainstream and has wide-ranging benefits for research, innovation, social change and education.

The INOS Project proposes that the overall educational, scientific, innovative and social impact of OS/CS/OI activities would be optimised if the learning components were grounded in solid pedagogy. To this end, we have developed the INOS Learning Design Framework (LDF), a resource for organisers to improve the educational value of their OS/CS/OI Learning Activities. The LDF allows organisers to make informed decisions about creating new or adapting existing activities, as well as provide guidance on organising, implementing and assessing the activities to ensure their sustainability.

The contents of the LDF is informed by established pedagogical principles, and state-of-the-art research of pedagogy in OS/CS/OI Learning Activities. The framework, presented as a form template, guides organisers through the process of learning design that extends from before, during and after the activity takes place. Steps of the LDF include: Goal Setting, Activity Development, Run Activity, and Reflection and Future Planning. The LDF is designed as a reiterative process. At any point, organisers may return to an earlier step of the LDF to refine or add elements. Organisers are free to adapt the framework to suit the individual needs of different Learning Activities.

In the LDF, activities may be developed via several pathways depending on the activity format. Activity formats include Passive Learning Activities, Discussion-Based Learning Activities, Informal Science Learning Activities, Inquiry-Based Learning Activities and Problem-Based Learning Activities. These activity formats are popularly used by HEIs and academic libraries. In addition, a General Template (Unclassified Format) is provided for activities that do not clearly fall into the popular activity format(s).

The LDF also aims to further develop the emerging field of pedagogy in OS/CS/OI Learning Activities by encouraging proper learning design procedure, which is currently not fully practiced in many OS/CS/OI Learning Activities. The LDF encourages organisers to establish proper learning goals and learning objectives, to conduct learning evaluation, to gather feedback from participants, and to use this information to improve future iterations of the activity and to also share this information with other organisers and stakeholders.

1. Introduction

1.1 Rationale

Open Science (OS), Citizen Science (CS) and Open Innovation (OI) are principles that promote decentralised, cross-border interaction in research and innovation. Their activities are transparent, accessible, shareable and open to collaboration. In all cases, science and innovation work is extended beyond its experts across fields, sectors, communities and cultures:

> *"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, 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"* (Sanz et al., 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"* (Simeone et al., 2017).

Overall, openness improves the quality of scientific and innovation outputs, especially in the face complex multidimensional issues that benefit from holistic problem solving (Hautamäki & Oksanen, 2016; Sanz et al., 2014). OS/CS/OI also promote public engagement with science and technology, openness and active citizenship. Openness is exponentially transitioning towards the mainstream and has wide-ranging implications on research, innovation and education. Coming from the perspectives of Higher Education Institutes (HEIs), academic libraries, and the area of learning design, we are interested in supporting the development of learning activities with an OS/CS/OI dimension (hereafter referred to as "OS/CS/OI Learning Activities").

OS/CS/OI Learning Activities often have social change aspirations, such as improved inclusivity in science/innovation, improved social relevance of science/innovation, improved relationships between non-experts and experts, improved awareness of causes, and the empowerment of citizens with knowledge to encourage fact-based societal change. For example, citizen environmental surveys and bioblitzes are often organised to advocate environmental awareness (City Nature Challenge, n.d.). Hackathons and similar innovation challenges are opportunities to gather multiple perspectives for problem-solving; they are also opportunities to raise awareness on certain issues, or to promote technical and soft skills in innovation work (Charosky et al., 2018; Li & Johnson, 2015).

OS/CS/OI Learning Activities are well-suited for online-based, home-based and distance learning. OS/CS/OI Learning Activities often take advantage of online resources that are openly accessible, which can be used as at-home learning tools and resources (e.g. open educational resources, open data, open software). Furthermore, as part of its open collaboration nature, OS/CS/OI Learning Activities are often designed to be learner-centred, meaning students are equipped with the skills, knowledge and guidance to learn with autonomy and independence. Many learning tasks can therefore easily take place at home and/or online.

The INOS Project proposes that the overall educational, scientific, innovative and social impact of OS/CS/OI activities would be optimised if the learning components were grounded in solid pedagogy. Currently, there is the opportunity to expand and improve the pedagogy of OS/CS/OI activities (see Section 2). To this end, we have developed the INOS Learning Design Framework (LDF) for OS/CS/OI Learning Activities.

> *The INOS Project aims to enhance the impact of OS/CS/OI Learning Activities by offering pedagogical support to HEIs and other activity organisers. The INOS Learning Design Framework (LDF) allows organisers to make informed decisions about creating new or adapting existing OS/CS/OI Learning Activities, as well as provide guidance on organising, implementing and assessing the activities to ensure their sustainability.*

The INOS LDF is complementary the INOS Implementation and Evaluation Framework for Open Knowledge Activities (O3A1), as well as the INOS Implementation and Evaluation Framework for Open Innovation Activities (O4A1) – access to all documents, as well as other project outputs, are available on the INOS Project website.

1.2 About OS/CS/OI Learning Activities

This section summarises information from other INOS research outputs, including a state-of-the-art analysis of recent OS/CS/OI Learning Activities, as well as a roadmap of recommended actions for organising OS/CS/OI Learning Activities – for more details, see O2A1 and O2A2 at this link (Teo, 2020b, 2020a).

In this LDF, Learning Activities are considered as follows:

- Learning Activities are defined as activities with intended learning outcomes.
- It is possible, but not necessary, for activities to also have intended research outcomes.
- We focus on activities typically organised by members of HEIs and academic libraries, although the LDF can be applied to activities organised by any other stakeholders.
- Learners/participants can be anyone, such as the general public, school children, university students, HEI staff and researchers, members of private organisations, and any other stakeholders.
- The duration of the learning activities can range from short (e.g. conducted within a day) to long (e.g. extended over weeks to months).

What makes an "OS/CS/OI" Learning Activity? **In this LDF, Learning Activities are not separated into OS, CS and OI activity types, and are instead considered collectively as "OS/CS/OI"**. We have combined these terms because OS, CS and OI share the fundamental principle of openness, and Learning Activities in these realms often have overlapping elements. Therefore, labelling the activity as either of these types is for the activity organiser to decide, depending on the open elements integrated and emphasised. Open elements in OS/CS/OI Learning Activities include:

- The use of OS/CS/OI tools and resources as learning tools and resources (e.g. open data, open software)
- The incorporation of open, cross-boundary participation and collaboration (e.g. interdisciplinary, inter-sectoral, experts with non-experts)
- The training of soft and technical skills necessary for OS and OI practice (e.g. open data training, soft skills in open collaboration)

- The generation of activity outputs that are made open access (e.g. in some participatory data collection activities, data is made public via an online data portal)
- The activity's availability as an open educational resource (e.g. license-free lesson plans, tools and resources).

The benefits of integrating open elements in Learning Activities include:

- Providing an authentic science/innovation experience with easy access to tools and resources (e.g. available online), and at little to no financial cost. For example, the pedagogical use of open access scientific resources, such as open data, open software and open hardware allows non-experts to use real scientific tools and data. This provides a genuine experience of scientific work and provides the opportunity for non-experts to gain practical knowledge and skills. Cross-boundary innovation projects also encourage participants of various backgrounds to collaborate, as open collaboration is the real nature of innovation work.
- Authentic experiences have been found to be engaging and motivating for participants. For instance, participants generally perceive real-world data as more interesting than artificial data constructed for learning activities. Being involved in real-world scientific research projects is also a strong motivator, as participants appreciate having real-world impact via their participation. In innovation-based projects, having students cater to their target end-users or their own communities also enables directly seeing the real-world usefulness of their work.

1.3 Popular Formats of OS/CS/OI Learning Activities by HEIs and Academic Libraries

For the purposes of learning design, we find that OS/CS/OI Learning Activities are better conceptualised according to learning goals and approaches. Our research in Teo (2020b) indicates that popular OS/CS/OI Learning Activities organised by HEIs and academic libraries can be represented by the following activity formats (also see Table 1.1):

1. **Passive Learning Activities** – Presentation-style learning activities with participants as the audience.
2. **Informal Science Learning Activities** – Participants are involved in certain stages of an existing research project led by experts/organisers. Participants' main contributions are typically data collection and/or basic data interpretation. Research topics can be of any field (science, social science, art etc.).
3. **Discussion-based Learning Activities** – Participants are placed in groups to discuss a topic and produce a collaborative artifact that demonstrates their learning.
4. **Inquiry-Based Learning Activities** – Participants conduct a research project using the scientific inquiry method. Research topics can be of any field (science, social science, art etc.).
5. **Problem-Based Learning Activities** – Cross-border groups of participants innovate a solution for a problem.

Table 1.1. Popular types of OS/CS/OI Learning Activities organised by HEIs and academic libraries can be represented by the following activity formats. All formats can be conducted online or at a physical venue. All are flexible to any field (e.g. science, social science, arts, design etc.). It is possible for organisers to combine multiple formats into their activities.

	Passive Learning Activities	Informal Science Learning Activities	Discussion-based Learning Activities	Inquiry-Based Learning Activities	Problem-based Learning Activities
General task	• Learning comes from observing a lecture-style presentation. • Typically, no learning artifact (i.e. an object created by students that demonstrates their learning).	• Learning comes from being involved in part of a research project led by experts/organisers. • Typically, no learning artifact.	• Learning is centred around a discussion that produces a new knowledge artifact. • Final output is a collaborative artifact (e.g. concept maps).	• Learning is centred around a research question that is answered via the scientific inquiry method. • Final output is a research finding.	• Learning is centred around a problem that needs solving. • Final output is an innovative product or service.
Learning goals and outcomes	• General and open learning goals e.g. to understand or raise awareness of certain topics. • Learning outcomes are typically not assessed in detail.	• General and open learning goals e.g. to understand or raise awareness of certain topics. • Learning outcomes depend on the type and level of participation. • Learning outcomes are typically not assessed in detail.	• To understand or raise awareness of certain topics. • To generate new ideas. • To enable joint decision-making. • To reflect on a topic. • Idea mapping. • To gain insight on various viewpoints.	• To understand or raise awareness of certain topics. • To improve understanding of the scientific inquiry method and how scientists work. • To develop technical skills in particular tools and technologies in science.	• To develop soft skills needed for open collaboration, with emphasis on teamwork, communication and methodologies. • To develop technical skills in particular tools and technologies in science and innovation.
Activity examples	• TED Talks – Experts share their knowledge in talks that are posted online for free distribution. • Pint of Science – Scientists share their latest research to a public audience in their local pub, bar or café. • Webinars	• iNaturalist – Participants map and share biodiversity field observations via a mobile app, producing open data. • Galaxy Zoo – Volunteers classify galaxies from telescope images. • Smithsonian Digital Volunteers – volunteers transcribe historical documents • Shakespeare's World - a project to transcribe handwritten documents by Shakespeare's contemporaries. • Wikipedia Edit-a-Thons by 500 Women Scientists	• Sharing Cities Action's co-creation activities – Stakeholders of different sectors collectively discuss the platform economy. • Knowledge Café – A group of people discuss a topic to better understand it. • Reversed Science Café, Science Expresso, and Scenario Workshop by The Sparks Project (Sparks Project, n.d.). • Dotmocracy Workshops – a simple method for group prioritisation or decision-making.	• nQuire – A platform where citizens conduct scientific projects of their own interest, with guidance for each inquiry step (Aristeidou et al., 2017). • iSCAPE Living Labs – Citizens and experts investigate local air pollution issues and collaborate on solutions. • iSpot – iSpot's embeds inquiry-based learning into their CS activity (Ansine et al., 2017)	• #EUvsVirus Challenge – Online-based hackathon in 2020 to develop innovative solutions for coronavirus-related challenges. • Challenge Based Innovation – Innovation program for university students to develop projects that solve complex societal problems.

	Passive Learning Activities	Informal Science Learning Activities	Discussion-based Learning Activities	Inquiry-Based Learning Activities	Problem-based Learning Activities
Activity examples based on descriptions by the Engage2020 Action Catalogue	• Science Café	• Participatory Sensing • Participatory Modelling • Serious Games	• Citizens Hearing • Citizens' Assembly • Civic Dialogue • Consensus Conference • Consensus Workshop • Crowd Wise • Deep Democracy – The Lewis Method • Deliberative (Mini-publics) Workshops • Deliberative Mapping • Deliberative Online Forum • Democs Card Game • E-conference • Future Search Conference • Future Workshop • Intake Question into Research Question • Perspective Workshop • Q methodology – stakeholder selection • Research Agenda Camp • Resource Flow Map • Scenario Workshop • Science Theatre • Serious Games • Stakeholder Working Groups • World Café • World Wide Views	• Action Research (also known as Participatory Action Research) • Citizen Science • Community-Based (Participatory) Research • Demand Driven Research in Curriculum • Science Shop • Science Week	• Challenge Prizes • Enrich by Co-design • Hackathon • Interdisciplinary Work Groups • Knowledge Atelier • Participatory Design (Co-design and practice-based research) • Reflexive Interactive Design

2. Approach of Framework

The LDF is built upon INOS research activities, including a state-of-the-art analysis of recent OS/CS/OI Learning Activities, as well as a roadmap of recommended actions for organising OS/CS/OI Learning Activities (Teo, 2020b, 2020a). This LDF, as a living document, will be continually developed as feedback is gathered from pilot events in 2020 and 2021.

This LDF supports and boosts the educational value of OS/CS/OI Learning Activities through several main strategies (Table 2.1). These strategies correspond to pedagogical challenges past OS/CS/OI Learning Activities have typically faced, as identified from our research (Teo, 2020b).

Table 2.1. This LDF supports and boosts the educational value of OS/CS/OI Learning Activities through the following main strategies.

Strategies to foster educational value in OS/CS/OI Learning Activities	Method in the INOS Learning Design Framework
Grounding the activity design in an established and comprehensive learning design framework, including the practice of proper learning evaluation.	The INOS LDF is based upon the Larnaca Declaration for Learning Design, which is an established framework to plan pedagogy (Dalziel et al., 2016). The INOS LDF follows the Teaching Cycle of the Larnaca Declaration to ensure that pedagogical consideration is carried out before, during and after the activity.
Maintaining synergy between learning goals/objectives and activity tasks.	The sequence of the LDF ensures that organisers reiteratively consider their learning goals/objectives when developing the activity tasks. This is especially important when there are other concurrent activity goals (e.g. research) that may affect achieving learning goals/objectives. The framework also includes learning evaluation, so that organisers can analyse the efficacy of their activities in delivering learning goals/objectives.
Enhancing participant interest, engagement and commitment.	The LDF incorporates gathering participant input before, during and after the activity. Participant input is then analysed to reiteratively improve the learning design of the activity. The LDF also encourages high participant engagement during activities (Figure 2.1). For example, participant engagement in Informal Science Learning Activities can be quite variable – some activities only engage participants as data generators, while others engage participants further via complementary learning tasks. Research has shown that treating participants only as data generators does not produce significant learning gains (Pandya & Dibner, 2019; Phillips et al., 2019). Therefore, the LDF also encourages organisers of Informal Science Learning Activities to incorporate complementary learning tasks to facilitate more cognitive thinking.
Addressing technical learning curves and challenges.	The LDF includes steps for organisers to consider any gaps of knowledge participants may have that would hinder achieving learning goals/objectives, as well as to consider if pre-training is needed.

Strategies to foster educational value in OS/CS/OI Learning Activities	Method in the INOS Learning Design Framework
Supporting the continued the development of pedagogical information in this field.	The LDF encourages organisers to collate and share pedagogical findings of their event, so to improve future iterations of the event, and to contribute to the development of educational OS/CS/OI Learning Activities.

An important aspect of the INOS LDF is flexibility. While OS/CS/OI Learning Activities can take various many forms, our state-of-the-art analysis revealed five popular activity formats of OS/CS/OI Learning activities, described in Section 1.3. The LDF provides individual support for each of these five activity formats. At the same time, the framework is open for adaptation to suit unique formats of individual activities. A general framework for activities with an "unclassified" format is also provided.

Throughout the framework, organisers are also free to choose from multiple options or to create their own method to action each step. This flexibility is important as organisers may have different resources available to them.

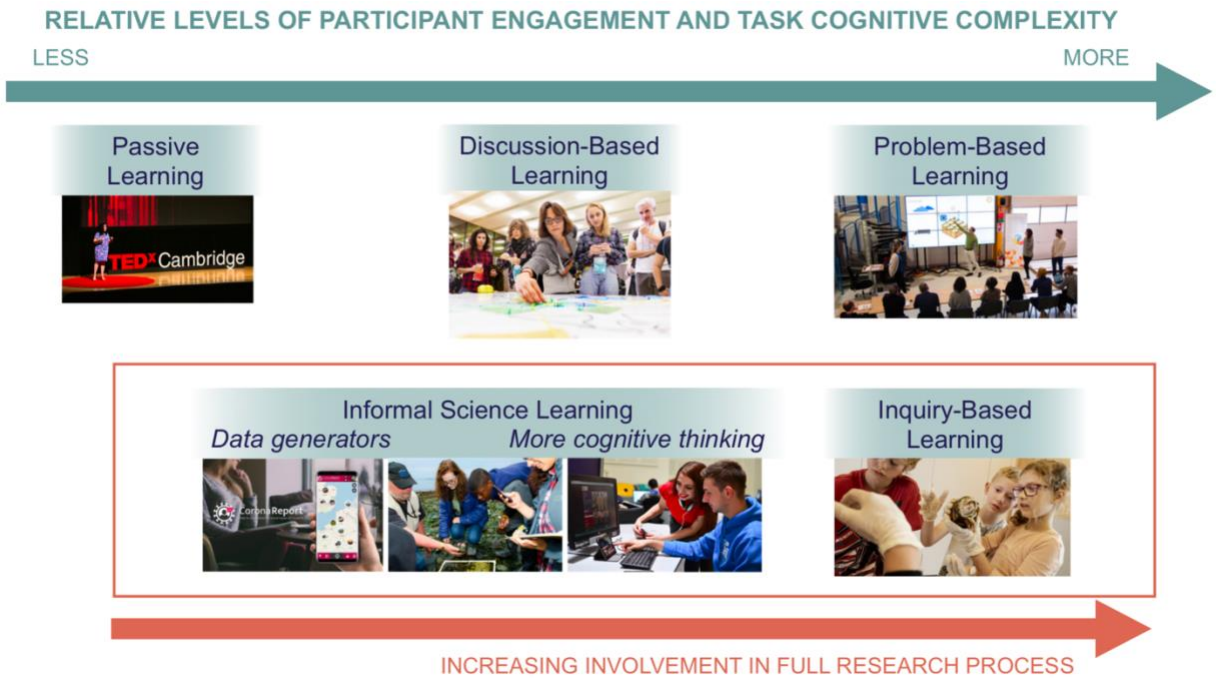

Figure 2.1. A comparison of the relative levels of participant engagement and task cognitive complexity between different OS/CS/OI Learning Activity Formats. The INOS Learning Design Framework encourages higher levels of participant engagement and task cognitive complexity, in order to enhance learning outcomes.

3. Instructions to Read Framework

Instructions on how to read the Learning Design Framework (LDF):

- The LDF is presented as a form template, which activity organisers progressively fill to develop their OS/CS/OI Learning Activities.
- The information sequentially prompted by the LDF form follows a line of decision-making that aims to strengthen the pedagogical value of the OS/CS/OI Learning Activities.
- It is recommended that organisers follow the sequence of the LDF as presented in Figure 3.1.
- The LDF is designed as a reiterative process. At any point, organisers may return to an earlier step of the LDF to refine or add elements.
- Checkbox lists (☐) describe options for consideration. Multiple checkboxes can be checked.
- Organisers are free to adapt the framework to suit the individual needs of different Learning Activities. For example, if an activity has multiple components, each with different activity formats, organisers may fill out or take inspiration from multiple format templates (i.e. Step 2b Options).

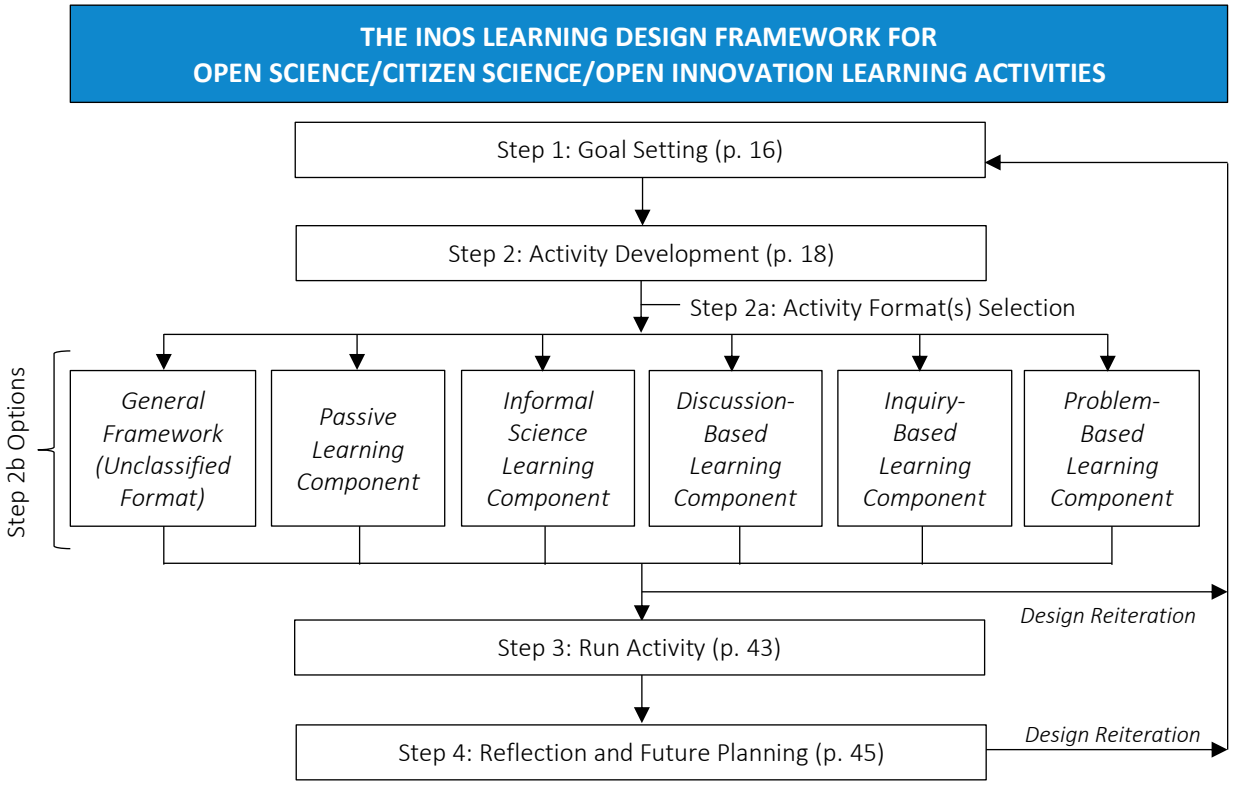

Figure 3.1. Overview of the Learning Design Framework for OS/CS/OI Learning Activities. The LDF is a reiterative process.

4. The INOS Learning Design Framework

Step 1: Goal Setting

As the foundation to inform further pedagogical decisions, this Step establishes key background information and the overarching goals of the activity. Details may be added or altered during design reiterations.

Table 4.1. Goal setting.

STEP 1: GOAL SETTING	
BASIC INFORMATION	
Name of event	
Topic	
Duration	
Main venue/platform	☐ Physical venue ☐ Online platform ☐ Mixed
Important resources	*Important factors affecting the design of the activity e.g. budget, space capacity etc.*
Similar activities	*Similar activities for reference and inspiration during learning design process.*
KNOW YOUR PARTICIPANTS	
Description of participants	*Important characteristics affecting learning e.g. age, community group etc.*
Participants' pre-activity knowledge of topic	☐ Limited (e.g. little to no knowledge of the topic) ☐ Basic (e.g. have heard of the topic before and understand basic concepts) ☐ Intermediate (e.g. high school-level knowledge of the topic) ☐ Advanced (e.g. university-level knowledge of the topic)

STEP 1: GOAL SETTING	
Participant input on learning design and learning expectations of event	Participant input is gathered via: ☐ Consultation/Focus group ☐ Survey ☐ Feedback from past activity ☐ Co-design of activity with participants ☐ Other: _____ Information to gather: ☐ What do participants expect to learn from the activity? ☐ What are their topic interests? ☐ What motivates participation in the activity?
OVERARCHING ACTIVITY GOALS	
Learning goals	*Develop learning goals that consider participant backgrounds, knowledge, input and expectations. Learning goals refer to higher-order, overall learning outcomes[1].*
Research/innovation goals (optional)	*If relevant, list any research/innovation outputs that will be generated from the activity.*
Elements of openness integrated into the learning activity	The activity will: ☐ Use open access tools and resources for learning ☐ Open data ☐ Open software ☐ Open hardware ☐ Other: _____ ☐ Involve diversity and cross-boundary collaboration and participation Participant groups: _____ ☐ Train participants soft and technical skills relevant to overall Open Science and Open Innovation practice Describe: _____ ☐ Generate outputs (e.g. research, innovation, pedagogical data) that are made open access Describe: _____

STEP 1: GOAL SETTING	
	☐ Be available as an open educational resource Describe: _____ ☐ Other: _____
UN Sustainable Development Goals – circle relevant	Information on each goal: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ 
NEXT STEP: ACTIVITY FORMAT SELECTION (P. 18)	

Additional resources:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

Step 2: Activity Development

In Step 2a, organisers first consider the format of their activity. Depending on the activity format selected, organisers then proceed to the corresponding Step 2b Option to design activity tasks, establish tools and resources, and design the learning evaluation method.

Step 2a: Activity Format(s) Selection

The appropriate format(s) for the activity depends on several factors. To determine the appropriate format(s) for your activity, consider:

1. Your learning goals, available resources, and other details established in Step 1: Goal Setting (p. 16).
2. The descriptions of each activity format (p. 10).
3. The learning goals and activity examples in Table 1.1 (p. 11), to identify which type of activity most closely resembles the activity you wish to organise.

Note:

- If the overall activity combines multiple activity formats, organisers may fill out or adapt multiple form templates.
- A General Template (Unclassified Format) is provided for activities that do not clearly fall into the available activity format(s). Even so, it is recommended that organisers also consider the content of the available activity format(s) that most closely resembles their planned activity.

Table 4.2. Activity format(s) selection for Activity Development.

STEP 2a: ACTIVITY FORMAT(S) SELECTION	
Activity format selected:	
NEXT STEP (DEPENDING ON ACTIVITY FORMAT SELECTED ABOVE): *GENERAL FRAMEWORK (UNCLASSIFIED FORMAT) – P.20* OR *PASSIVE LEARNING COMPONENT – P. 24* OR *INFORMAL SCIENCE LEARNING COMPONENT – P. 27* OR *DISCUSSION-BASED LEARNING COMPONENT – P. 31* OR *INQUIRY-BASED LEARNING COMPONENT – P. 34* OR *PROBLEM-BASED LEARNING COMPONENT – P. 39*	

Step 2b Option: General Framework (Unclassified Format)

This template is a General Framework for Activity Development, for activities that do not clearly fall into the available activity format(s). This template asks organisers to consider learning objectives, pre-training, the main task, complementary learning tasks, communication methods, tools and resources, as well as learning evaluation.

Table 4.3. General Framework for Activity Development, for activities that do not clearly fall into the available activity format(s).

STEP 2b OPTION: GENERAL FRAMEWORK (UNCLASSIFIED FORMAT)	
ACTIVITY DESIGN	
Learning objectives	*Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.*[1]
Pre-training	Setting: ☐ Physical venue: _____ ☐ Online: _____ Pre-training content to include: ☐ Background of project ☐ Basic/necessary knowledge of topic to perform main task ☐ Bonus knowledge of topic ☐ Technical instructions for main task ☐ Other: _____ Pre-training will be delivered via: ☐ Online videos ☐ Website ☐ Infographics ☐ MOOC ☐ Live demonstration ☐ App instructions ☐ Game ☐ Q&A session ☐ Documents ☐ Other: _____
Main task	Setting: ☐ Physical venue: _____ ☐ Online: _____ Description of main task: How is the main task able to achieve the learning objectives? Consider complementary learning tasks if there is still opportunity to strengthen the educational value of the activity.

STEP 2b OPTION: GENERAL FRAMEWORK (UNCLASSIFIED FORMAT)	
Complementary learning tasks	Setting: ☐ Physical venue: _____ ☐ Online: _____ Complementary learning tasks to enhance the achievement of learning objectives: ☐ Learning exercises with collected data from main task ☐ Group reflection exercise to summarise learning outcomes ☐ Other: _____
Mode of communication between participants and experts during tasks	Continuous communication between participants and experts are established via: ☐ Participants conducting main task with experts/demonstrators present ☐ If main task is done remotely from experts, the below method is used for contact: ☐ Online call ☐ Phone call ☐ Online chat/forum ☐ Email ☐ Other: _____
TOOLS AND RESOURCES	
Tools and resources	
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of participants who completed activity

STEP 2b OPTION: GENERAL FRAMEWORK (UNCLASSIFIED FORMAT)	
	☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of questions and discussions ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:
+ ENHANCING EDUCATIONAL VALUE	
☐ Topic is chosen by, developed by and personally relevant to the participants. Personal relevance has been found to highly motivate learning. ☐ Communication with participants throughout the activity is important to create more engagement and learning. ☐ Activity outputs are shared between different participant groups. ☐ Contextualise the main task with sufficient pre-training so that participants understand the significance of their contribution. ☐ Maintain an open line of communication with participants throughout the activity. Ensure participants are aware of this facility. Higher engagement between experts and participants is conducive for learning. ☐ Run complementary learning tasks to enhance engagement and to achieve learning objectives effectively. ☐ Provide supplementary educational material and support so that activity may be integrated into existing school/university curricula (i.e. open educational resources). ☐ Design activity together with educators (e.g. schoolteachers) to ensure synergy between learning goals/objectives and activity tasks, as well as to create a meaningful and socially relevant activity. ☐ Provide participants guidance on how to expand their knowledge in the topic after the activity. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.	

STEP 2b OPTION: GENERAL FRAMEWORK (UNCLASSIFIED FORMAT)
+ ENHANCING OPENNESS
☐ Make presentations available online (e.g. livestreaming, recordings) as open educational resources. ☐ Use of open source software and hardware in tasks. ☐ Research topic is relevant and meaningful to participants' lives. ☐ Data collected is made open access to the public and encouraged to be used. ☐ Collaboration artifacts are collected and made open access. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) OR RUN ACTIVITY (P. 43)

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

Step 2b Option: Passive Learning Component

Passive Learning Activities are presentation-style learning activities with participants as the audience. This template encourages high participant engagement via collaborative artifacts and/or collective discussions, as active learning is more effective in producing learning outcomes.

Table 4.4. Activity Development for Passive Learning Component.

<table>
<tr><th colspan="3">STEP 2b OPTION: PASSIVE LEARNING COMPONENT</th></tr>
<tr><td colspan="3">ACTIVITY DESIGN</td></tr>
<tr><td rowspan="3">Presentation title(s) and learning objectives

Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.[1]</td><td colspan="2">Setting: ☐ Physical venue: _____ ☐ Online: _____</td></tr>
<tr><td>Title 1:

Learning objective:</td><td>Title 2:

Learning objective:</td></tr>
<tr><td>Title 3:

Learning objective:</td><td>Title 4:

Learning objective:</td></tr>
<tr><td>Participant engagement</td><td colspan="2">Setting: ☐ Physical venue: _____ ☐ Online: _____

Participants will engage with the presented content in an in-depth manner via:
☐ Live questions ☐ Live polling ☐ Online chat/forum
☐ Q&A session ☐ Discussion roundtables ☐ Reception with presenter(s)
☐ A collaborative artifact (e.g. interactive wall, Twitter discussion, photo challenge)
☐ Other: _____</td></tr>
</table>

STEP 2b OPTION: PASSIVE LEARNING COMPONENT	
TOOLS AND RESOURCES	
Tools and resources	☐ Audio-visual tools ☐ Web conferencing software ☐ Tools for participant engagement ☐ Other: _____
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of questions during Q&A ☐ Online chat/forum activity ☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of questions during Q&A ☐ Quality of discussion during roundtables/online chat/forum ☐ Evidence of advanced thinking in collaborative artifact ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:

STEP 2b OPTION: PASSIVE LEARNING COMPONENT
+ ENHANCING EDUCATIONAL VALUE
☐ Enable participant engagement during the event as much as possible via communication and/or creating a collaborative artifact. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.
+ ENHANCING OPENNESS
☐ Make presentations available online (e.g. livestreaming, recordings) as open educational resources. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) OR RUN ACTIVITY (P. 43)

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

Step 2b Option: Informal Science Learning Component

In Informal Science Learning Activities, participants are involved in certain stages of an existing research project led by experts/organisers. Participants' main contributions are data collection and/or basic data interpretation. Research topics can be of any field (science, social science, art etc.). This template aims to enhance the activity's educational value by getting organisers to plan pre-training, to support communication between experts and participants during the main task, and to include complementary learning tasks to better achieve learning objectives.

Table 4.5. Activity Development for Informal Science Learning Component.

STEP 2b OPTION: INFORMAL SCIENCE LEARNING COMPONENT	
ACTIVITY DESIGN	
Learning objectives	*Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.*[1]
Stages of scientific inquiry method in which participants are involved	In the main project, participants are involved in: ☐ 1. Designing research question ☐ 2. Hypothesis generation ☐ 3. Data collection ☐ 4. Basic data interpretation[2] ☐ 5. Analysis of results and conclusion Based on above, the level of participation[3] is: ☐ Level 1: Crowdsourcing (only #3 checked) ☐ Level 2: Distributed intelligence (only #4 checked) ☐ Level 3: Participatory science (only #1-3 checked) * ☐ Level 4: Extreme science (#1-5 checked) * * If Level 3 or 4 selected, this activity may be better designed as an Inquiry-Based Learning Activity (p. 34)
Pre-training	Setting: ☐ Physical venue: _____ ☐ Online: _____ Pre-training content to include: ☐ Background of research project (goals, future data applications, project outcomes) ☐ Basic/necessary knowledge of topic to perform main task ☐ Bonus knowledge of topic ☐ Technical instructions for main task ☐ Other: _____ Pre-training will be delivered via: ☐ Online videos ☐ Website ☐ Infographics ☐ MOOC ☐ Live demonstration ☐ App instructions ☐ Game ☐ Q&A session ☐ Documents ☐ Other: _____

STEP 2b OPTION: INFORMAL SCIENCE LEARNING COMPONENT	
Main task (i.e. contribution to research project)	Setting: ☐ Physical venue: _____ ☐ Online: _____ Description of main task: Continuous communication between participants and experts are established via: ☐ Participants conducting main task with experts/demonstrators present ☐ If main task is done remotely from experts, the below method is used for contact: ☐ Online call ☐ Phone call ☐ Online chat/forum ☐ Email ☐ Other: _____ Optional methods for motivation: ☐ Gamification ☐ Challenges ☐ Role-play
Complementary learning tasks	Setting: ☐ Physical venue: _____ ☐ Online: _____ Learning tasks to achieve learning objectives: ☐ Learning exercises with collected data ☐ Group reflection exercise to summarise learning outcomes ☐ Other: _____ Describe learning tasks further:
TOOLS AND RESOURCES	
Tools and resources	Data collection/submission: ☐ Mobile app ☐ Specialised (open) hardware/sensor ☐ Online form ☐ Online database ☐ Online/Computer-based program ☐ Other: _____ Data interpretation: ☐ Data visualisation/analysis software ☐ Computers/Laptops ☐ Other: _____

STEP 2b OPTION: INFORMAL SCIENCE LEARNING COMPONENT	
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of participants who completed activity ☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of questions and discussions ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:
+ ENHANCING EDUCATIONAL VALUE	
☐ Contextualise the main task with sufficient pre-training so that participants understand the significance of their contribution. ☐ Maintain an open line of communication with participants throughout the activity. Ensure participants are aware of this facility. Higher engagement between experts and participants is conducive for learning. ☐ Run complementary learning tasks to enhance engagement and to achieve learning objectives effectively. ☐ Provide supplementary educational material and support so that activity may be integrated into existing school/university curricula (i.e. open educational resources). ☐ Design activity together with educators (e.g. schoolteachers) to ensure synergy between learning goals/objectives and activity tasks, as well as to create a meaningful and socially relevant activity. ☐ Involve participants further in the scientific process by converting this Informal Science Learning Activity into a full Inquiry-Based Learning Activity (p. 34). Doing so has the greatest potential in learning improvements. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.	

STEP 2b OPTION: INFORMAL SCIENCE LEARNING COMPONENT
+ ENHANCING OPENNESS
☐ Use of open source software and hardware in tasks. ☐ Research topic is relevant and meaningful to participants' lives. ☐ Data collected is made open access to the public and encouraged to be used. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) *OR* ***RUN ACTIVITY (P. 43)***

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

[2] Here, "basic data interpretation" refers to where participants contribute a basic level of data analysis, and do not contribute to the development of more significant, final findings. For example, in the case of Galaxy Zoo, participants help identify galaxies from telescope images, but are not involved in the analysis of the full dataset produced by the participants (it is instead done by the experts). This would be considered basic data interpretation.

[3] Levels of participation as defined by Haklay (2013):

Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In D. Sui, S. Elwood, & M. Goodchild (Eds.), *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice* (pp. 105–122). Springer.

Additional resources:

Herodotou, C. (2018). Citizen science and informal learning: A brief commentary. In R. Luckin (Ed.), *Enhancing Learning and Teaching with Technology: What the Research Says*. UCL Institute of Education Press.

Pandya, R., & Dibner, K. A. (2019). Learning through citizen science: Enhancing opportunities by design. In *Learning Through Citizen Science: Enhancing Opportunities by Design*. Washington DC: The National Academies Press.

Phillips, T. B., Ballard, H. L., Lewenstein, B. V., & Bonney, R. (2019). Engagement in science through citizen science: Moving beyond data collection. *Science Education*, 103(3), 665–690.

Step 2b Option: Discussion-Based Learning Component

In Discussion-Based Learning Activities, participants are placed in groups to discuss a topic and produce a collaborative artifact that demonstrates their learning.

Table 4.6. Activity Development for Discussion-Based Learning Component.

STEP 2b OPTION: DISCUSSION-BASED LEARNING COMPONENT	
ACTIVITY DESIGN	
Learning objectives	*Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.*[1]
Pre-discussion	Setting: ☐ Physical venue: _____ ☐ Online: _____ Topic is: ☐ Provided by the organiser(s) ☐ Developed by the participant ☐ Chosen by participants from a domain provided by the organiser(s) Pre-discussion content to include: ☐ Background of activity (goals, applications, outcomes) ☐ Basic/necessary knowledge of topic to perform main discussion ☐ Technical instructions for main discussion ☐ Other: _____ Pre-discussion content will be delivered via: ☐ Live presentation ☐ Website ☐ Infographics ☐ MOOC ☐ Online video ☐ App instructions ☐ Game ☐ Q&A session ☐ Other: _____
Main discussion and collaboration	Setting: ☐ Physical venue: _____ ☐ Online: _____ Number of participants per group: _____ The discussion centres around producing a collaboration artifact: ☐ Idea wall (e.g. post-it notes) ☐ Idea mapping (e.g. concept map, mind map) ☐ Summary of discussion/Reflection ☐ Plan ☐ Design ☐ Model/Prototype ☐ Group presentation ☐ Infographic ☐ Report ☐ Theatre performance/fine art ☐ Playing a game (e.g. serious games, board games, card games, online game) ☐ Other: _____

STEP 2b OPTION: DISCUSSION-BASED LEARNING COMPONENT	
TOOLS AND RESOURCES	
Tools and resources	☐ Web conferencing software (e.g. Zoom, Adobe Connect, Microsoft Teams, Skype) ☐ Collaboration and file-sharing software (e.g. Miro, Google Drive) ☐ Physical space for discussion ☐ Stationery ☐ Other: _____
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of participants who completed activity ☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of discussions ☐ Evidence of advanced thinking in collaborative artifact ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:
+ ENHANCING EDUCATIONAL VALUE	
☐ Collaboration artifacts are shared between different participant groups. ☐ Provide participants guidance on how to expand their knowledge in the topic after the activity. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.	

STEP 2b OPTION: DISCUSSION-BASED LEARNING COMPONENT
+ ENHANCING OPENNESS
☐ Consider multiple dimensions of diversifying participants in a group. ☐ Use of open source software and hardware in tasks. ☐ Research topic is relevant and meaningful to participants' lives. ☐ Collaboration artifacts are collected and made open access. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) OR *RUN ACTIVITY (P. 43)*

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

Additional resources:

Paavola, S., & Hakkarainen, K. (2014). Trialogical Approach for Knowledge Creation. In S. C. Tan, W. O. Lee, D. W. L. Hung, L. W. Teh, S. C. Tan, H. J. So, & J. Yeo (Eds.), *Knowledge Creation in Education* (pp. 123–142). Springer Science+Business Media. https://doi.org/10.1007/978-981-287-047-6

Step 2b Option: Inquiry-Based Learning Component

In Inquiry-Based Learning Activities, participants conduct a research project using the scientific inquiry method. Research topics can be of any field (science, social science, art etc.). The template is based on the phases of Inquiry-Based Learning (Pedaste et al., 2015).

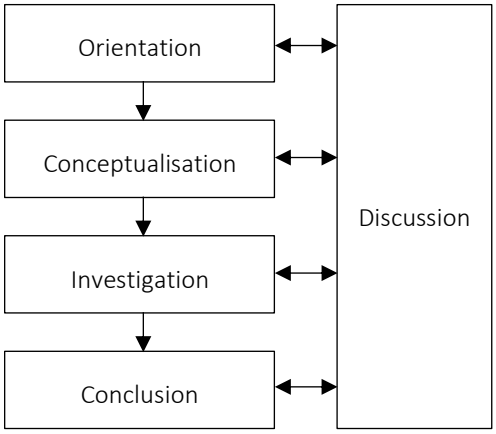

Figure 4.1. The phases of Inquiry-Based Learning simplified from Pedaste et al. (2015). Discussion is an ongoing activity that takes place throughout the learning sequence.

Table 4.7. Activity Development for Inquiry-Based Learning Component.

STEP 2b OPTION: INQUIRY-BASED LEARNING COMPONENT	
ACTIVITY DESIGN	
Learning objectives	*Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.*[1]
Orientation	Setting: ☐ Physical venue: _____ ☐ Online: _____ Topic is: ☐ Provided by the organiser(s) ☐ Developed by the participant ☐ Chosen by participants from a domain provided by the organiser(s)

STEP 2b OPTION: INQUIRY-BASED LEARNING COMPONENT	
	Orientation content to include: ☐ Background knowledge of topic to stimulate interest and curiosity ☐ Background knowledge of scientific inquiry method ☐ Technical knowledge on scientific tools ☐ Other: _____ Orientation content to be delivered via: ☐ Presentations ☐ Online videos ☐ Interviews ☐ Documents ☐ Books ☐ Websites ☐ Infographics ☐ MOOC ☐ Game ☐ Participants' independent research ☐ Other: _____ Describe learning tasks further:
Conceptualisation	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objectives: 1. Develop research question 2. Develop hypotheses Describe learning tasks further:
Investigation	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objectives: 1. Designing an experiment/investigation to test hypotheses 2. Conducting the experiment/investigation 3. Data interpretation Task options: ☐ Outdoor fieldwork ☐ Lab/Indoor experimentation ☐ Open data/Online data mining ☐ Other: _____ Describe learning tasks further:

STEP 2b OPTION: INQUIRY-BASED LEARNING COMPONENT	
Conclusion	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objectives: 1. Drawing conclusions from data and comparing with research questions/hypotheses Describe learning tasks further:
Discussion (task options for previous phases of inquiry-based learning)	Setting: ☐ Physical venue: _____ ☐ Online: _____ Self-reflection tasks[2]: ☐ Role-play ☐ Writing a diary ☐ Writing a narrative ☐ Explanation ☐ Guiding questions ☐ Writing a report ☐ Other: _____ Group-sharing and reflection tasks: ☐ Presentations ☐ Group discussions ☐ Peer-assessments ☐ Consultation with experts ☐ Publication of research outcomes ☐ Data visualisation/Infographics ☐ Other: _____ Describe learning tasks further:
TOOLS AND RESOURCES	
Tools and resources	Investigation tools: ☐ Specialised (open) hardware/sensor ☐ Mobile app ☐ Data visualisation/analysis software ☐ Computers/Laptops ☐ Open dataset ☐ Other: _____ Collaboration tools: ☐ Web conferencing software (e.g. Zoom, Adobe Connect, Microsoft Teams, Skype) ☐ Collaboration and file-sharing software (e.g. Miro, Google Drive) ☐ Other: _____

STEP 2b OPTION: INQUIRY-BASED LEARNING COMPONENT	
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of participants who completed activity ☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of questions and discussions ☐ Evidence of advanced thinking in learning tasks ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:
+ ENHANCING EDUCATIONAL VALUE	
☐ Research topic is chosen by, developed by and personally relevant to the participants. Personal relevance has been found to highly motivate learning. ☐ Provide support as needed to participants to conduct their research projects, such as via expertise and guidance. ☐ Communication with participants throughout the activity is important to create more engagement and learning. ☐ Provide supplementary educational material and support so that activity may be integrated into existing school/university curricula (i.e. open educational resources). ☐ Design activity together with educators (e.g. schoolteachers to ensure synergy between learning goals/objectives and activity tasks, as well as to create a meaningful and socially relevant activity. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.	

STEP 2b OPTION: INQUIRY-BASED LEARNING COMPONENT
+ ENHANCING OPENNESS
☐ Use of open source software and hardware in tasks. ☐ Research topic is relevant and meaningful to participants' lives. ☐ Research outcomes are made open access to the public. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) *OR* ***RUN ACTIVITY (P. 43)***

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

[2] See Runnel et al. (2013) for more information:

Runnel, M. I., Pedaste, M., & Leijen, Ä. (2013). Model for guiding reflection in the context of inquiry-based science education. *Journal of Baltic Science Education*, *12*(1), 107–118.

Additional resources:

Pedaste, M., Mäeots, M., Siiman, L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61.

Step 2b Option: Problem-Based Learning Component

In Problem-Based Learning Activities, cross-border groups of participants innovate a solution towards a problem.

Table 4.8. Activity Development for Problem-Based Learning Component.

STEP 2b OPTION: PROBLEM-BASED LEARNING COMPONENT	
PARTICIPANTS' DIVERSITY	
Collaborators	Number of collaborators per group: _____ Collaborators include: ☐ Academic researchers ☐ University postgraduate students ☐ University undergraduate students ☐ High/Secondary school students ☐ Younger school students ☐ Citizens/General public/Non-experts ☐ Private sector ☐ Government sector ☐ Other: _____
Type of cross-border collaboration	Diversity between collaborators are: ☐ Interdisciplinary ☐ Inter-sectoral ☐ Inter-cultural ☐ Inter-community ☐ Experts with non-experts ☐ Other: _____
LEARNING TASK	
Learning objectives	*Learning objectives are the specific, measurable competencies to assess if your learning goals have been met.*[1]
Ideation	Setting: ☐ Physical venue: _____ ☐ Online: _____ Problem is: ☐ Provided by the organiser(s) ☐ Developed by the participant ☐ Chosen by participants from a domain provided by the organiser(s) Task objectives: 1. Topic exploration, needfinding 2. Defining a problem 3. Brainstorming solution ideas Task options: ☐ Secondary research (literature, websites, open data) ☐ Observing/consultations with target end-users

STEP 2b OPTION: PROBLEM-BASED LEARNING COMPONENT	
	☐ Group discussion/brainstorm ☐ Other: _____ Describe learning tasks further:
Design	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objectives: 1. Design model(s) 2. Prototype design(s) Describe learning tasks further:
Implementation	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objectives: 1. User testing 2. Reiterative design Task options: ☐ Test runs with target users ☐ Focus groups ☐ Consultation with experts ☐ Other: _____ Describe learning tasks further:
Communication	Setting: ☐ Physical venue: _____ ☐ Online: _____ Task objective: 1. Presentation and discussion of final outputs 2. Dissemination of final output for real-world application Task options: ☐ Presentations ☐ Group discussions ☐ Peer-assessments ☐ Consultation with experts ☐ Documentation of project outcomes ☐ Publication of project outcomes ☐ Other: _____ Describe learning tasks further:

STEP 2b OPTION: PROBLEM-BASED LEARNING COMPONENT	
TOOLS AND RESOURCES	
For collaboration: ☐ Physical space for discussion ☐ Web conferencing software ☐ Collaboration and file-sharing software ☐ Other: _____ Resources for design/prototyping: ☐ Makerspaces/fablabs ☐ Virtual reality platforms ☐ Specialised (open) tools/hardware ☐ Design software ☐ Other: _____	
LEARNING EVALUATION DESIGN	
Learning evaluation information and data	This information is needed to determine if the learning objectives have been achieved (select and add relevant): ☐ Participant numbers and demographics ☐ Participant engagement during the event ☐ Participant-identified level of interest ☐ Number of participants who completed activity ☐ Participant learning from event ☐ Comparison of pre- and post-event knowledge of topic ☐ Quality of questions and discussions ☐ Evidence of advanced thinking in learning tasks ☐ Innovative value of the project outputs ☐ Participant suggestions for improvement and general feedback ☐ Other information and data:
Evaluation method	Describe the method to gather the above evaluation data. ☐ Live feedback from participants ☐ Data analytics (e.g. online activity data) ☐ Assessment (e.g. quiz) ☐ Evaluation (e.g. event survey) ☐ Other: _____ Describe method further:

STEP 2b OPTION: PROBLEM-BASED LEARNING COMPONENT
+ ENHANCING EDUCATIONAL VALUE
☐ Problem is chosen by, developed by and personally relevant to the participants. Personal relevance has been found to highly motivate learning. ☐ Provide support as needed to participants to conduct their projects, such as via expertise and guidance. ☐ Communication with participants throughout the activity is important to create more engagement and learning. ☐ Design activity together with educators (e.g. school teachers) to ensure synergy between learning goals/objectives and activity tasks, as well as to create a meaningful and socially relevant activity. ☐ Documentation and open access sharing of pedagogical information and learning outcomes.
+ ENHANCING OPENNESS
☐ Consider multiple dimensions of diversifying participants in a group. ☐ Encourage direct interaction between participants and their project end-users throughout the project, to maximise real-world application of their project. ☐ Use of open source software and hardware in tasks. ☐ Project topic is relevant and meaningful to participants' lives. ☐ Project outcomes are made open access to the public. ☐ Increase the diversity of the participants, especially to underrepresented groups. Consider how the activity's design may affect participant demographics.
NEXT STEP: DESIGN REITERATION (P. 16) OR RUN ACTIVITY (P. 43)

Notes:

[1] For more information about writing learning goals and learning objectives:

The Derek Bok Center for Teaching and Learning. (2020). *On Learning Goals and Learning Objectives*. The Derek Bok Center for Teaching and Learning. https://bokcenter.harvard.edu/learning-goals-and-learning-objectives

Step 3: Run Activity

This Step, which occurs during the activity, is of equal importance to the other Steps of learning design, as activities are often spontaneously adapted during the event. Table 4.9 ***acts as a checklist of tasks for organisers when running the activity and engaging with participants – it should be read before the activity so that organisers are aware of tasks to carry out during the activity. Table*** 4.10 ***may be filled out during or immediately after the activity, to document any changes made while the activity was running.***

Table 4.9. Run Activity (checklist). This template may be filled out before the activity is run, so that organisers are aware of tasks that carry out during the activity.

STEP 3: RUN ACTIVITY	
TASKS FOR ORGANISERS	
Pre-activity	☐ Ensure learning tools and resources are available ☐ Demonstrators are trained/prepared to carry out activity and are aware of the design elements developed in Step 2b. ☐ Ensure demonstrators are aware of the learning evaluation methods and tools ☐ Ensure demonstrators are aware of the methods and tools for communication with participants
Run activity and engage with participants	☐ Ensure learning tools and resources are available to all participants ☐ Ensure participants receive sufficient instructions/briefings/pre-training ☐ Engage with participants during the activity to determine if the activity is effective in delivering learning goals and objectives. ☐ Monitor progress of participants as they carry out learning tasks ☐ Receive live feedback from participants
Activity design adjustments (during the activity)	☐ Based on live feedback and observations, identify challenges affecting learning, such as: ☐ Sufficiency/clarity of guidance and support for students ☐ Group dynamics/sizes ☐ Technological challenges ☐ Logistical challenges ☐ Other: _____ ☐ If able, discuss adjustments to the design the activity and implement them. Record all changes and outcomes. Continue to observe participants and receive feedback. See Activity Design Adjustments (During Activity), p. 44.
Learning evaluation	☐ Collect learning evaluation information, as designed in Step 2b.
NEXT STEP: REFLECTION AND FUTURE PLANNING (P. 45)	

Table 4.10. Activity Design Adjustments (During Activity) as part of Step 3: Run Activity. This template may be filled out during or immediately after the activity, to document any changes made while the activity was running.

ACTIVITY DESIGN ADJUSTMENTS (DURING ACTIVITY)		
Challenges	**Adjustments**	**Outcomes of adjustment**
Example 1: Participants were confused how to conduct data analysis task *Example 2: Certain group members were unable to participate in discussions.*	*Participants were given additional instruction. May need to consider pre-training in future iterations of activity.* *Groups were reorganised, and group sizes were reduced.*	*Participants were able to conduct task, but a lot of activity time was wasted to deliver additional instruction.* *Improved group dynamics.*

Step 4: Reflection and Future Planning

A checklist of tasks for organisers after the activity, for reflection and future planning. This Step encourages organisers to collate and share their pedagogical findings, to improve future iterations of the activity and to develop the field further.

Table 4.11. Reflection and Future Planning.

STEP 4: REFLECTION AND FUTURE PLANNING	
	TASKS FOR ORGANISERS
Reflection (post-activity)	☐ Gather all activity evaluation information. This includes: ☐ Learning evaluation information and data ☐ Testimonials and observations from demonstrators ☐ Records of live feedback from and observations of participants ☐ Records of challenges, interventions and outcomes during the activity (p. 44) ☐ Discuss and analyse activity evaluation information to identify: ☐ Strengths of activity design to deliver learning goals/objectives ☐ Weaknesses of activity design to deliver learning goals/objectives ☐ Interventions during the activity that were successful or unsuccessful ☐ Difficulties organisers/demonstrators faced in facilitating the activity ☐ Technical or logistical difficulties ☐ Discuss and establish strategies for improving future activities ☐ Alterations and additions to the activity's design ☐ Contingency plans for possible challenges in future activities ☐ Professional development activities for organisers/demonstrators to address difficulties and challenges when facilitating the activity, such as via: ☐ Professional development courses/training ☐ Gaining additional personal experience ☐ Learning from experience of organisers of other similar activities
Communication and field development	☐ Identify key pedagogical findings from your experience ☐ Record and share pedagogical findings via: ☐ Publishing in a relevant open access journal ☐ Publishing open access documents available online ☐ Posting an article/blog post on the project/event website ☐ Linking above resources and share key findings on social media (e.g. Twitter hashtag, LinkedIn, Academia.edu, ResearchGate). Ensure findings are accessible to other organisers of OS/CS/OI Learning Activities. ☐ Participate and present findings in relevant conferences and workshops

STEP 4: REFLECTION AND FUTURE PLANNING	
	☐ Organise (online) conferences and workshops that enable discussion of pedagogy in OS/CS/OI Learning Activities ☐ Personally share experiences with other organisers of OS/CS/OI Learning Activities ☐ Conduct training for other activity organisers ☐ Other: _____
NEXT STEP: DESIGN REITERATION (P. 16)	

Table 4.12. Reflection and Future Planning Template (Post-Activity), as part of Step 4.

REFLECTION AND FUTURE PLANNING TEMPLATE (POST-ACTIVITY)	
STRENGTHS OF ACTIVITY	
Strengths	Elements to keep for next activity
CHALLENGES OF ACTIVITY	
Challenges	Strategies to manage challenges for next activity

5. Conclusion

The INOS Project proposes that the overall educational, scientific, innovative and social impact of Open Science, Citizen Science and Open Innovation (OS/CS/OI) activities would be optimised if the learning components were grounded in solid pedagogy. Currently, there is the opportunity to expand and improve the pedagogy of OS/CS/OI activities.

This document presents the INOS Learning Design Framework, which aims to foster the educational value OS/CS/OI Learning Activities. Previous INOS research activities of past OS/CS/OI Learning Activities revealed a number of pedagogical challenges that hinders learning outcomes. The framework was produced to address these challenges – these strategies include:

- Grounding the activity design in an established and comprehensive learning design framework, including the practice of proper learning evaluation.
- Maintaining synergy between learning goals/objectives and activity tasks.
- Enhancing participant interest, engagement and commitment.
- Addressing technical learning curves and challenges.
- Supporting the continued the development of pedagogical information in this field.

As a living document, the framework will be continually developed as feedback is gathered from pilot events in 2020 and 2021.

6. 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). Feedback and queries may be delivered via our email address (inos.project.eu@gmail.com).

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