STEAM LEARNING ECOLOGIES

LEARNER ENGAGEMENT EVALUATION METHODOLOGY

Deliverable 4.1

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D4.1 Learner Engagement Evaluation Methodology			
Work Package	WP4 Learner Engagement in SLEs		
Lead Partner	University of Cyprus		
Author(s)	Tasos Hovardas (UCY), Kyriaki Vakkou (UCY), & Konstantina Arampatzi (UCY)		
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Executive Summary

The present deliverable describes the methodology to be followed by stakeholders for participatory pedagogical design in Task 4.1 (Learning paths through SLEs). The main objective of this task and deliverable is to coordinate stakeholders in a SLE in fulfilling their major role, which is to offer learning opportunities and engage learners. Partners in the consortium most likely will not themselves produce any new learning material, which means that the learning opportunities to be offered in SLEs should be based on existing and properly adapted learning resources. Moreover, these resources should be arranged so as to produce a learning path to be followed by learners.

Main themes for participatory pedagogical design include: (1) Potential learning paths (how resources can be utilized to form learning routes; decision trees based on learner choices in the open learning environments of SLEs); (2) Learning products to be created by students themselves along learning paths; (3) Curriculum mapping of knowledge and skills as reflected by learning products; (4) Support and guidance to be provided by stakeholders to students along learning paths; (5) Opportunities for female engagement; (6) Career opportunities. Learning products will be a major focus of the evaluation of learner engagement. A coding scheme will be utilized for their assessment. A survey for stakeholders in SLEs will be also administered for reflecting upon learner routes, while interviews and focus groups will be conducted with selected members of stakeholders for the same purpose. “Digital recognition badges” will be awarded to SLE initiators, stakeholders, and learners with outstanding contributions to catalyse peer support and community development.

With regard to the methodological framework of SLEs, learner meaningful engagement is pursued through two main components: (1) STE(A)M, and (2) the inclusion of both formal and non-formal/informal learning settings. Prototype SLEs documented by consortium partners in this deliverable reflect the diversity and heterogeneity of stakeholders both within as well as across potential SLEs. Many of the provided SLEs offer alternative learning paths and cater to the individual preferences and interests of students. Simultaneously, several of them, emphasize real-world application by involving students in projects that address practical challenges, contributing to bridging the gap between classroom learning and real-world problem solving. Furthermore, the inclusivity of the designs of SLEs, appealing to learners of all genders, demonstrates a commitment to diversity and equal access to educational opportunities. The learning pathways that are provided align with potential career opportunities in STEAM fields. Students are expected to gain practical experiences and insights into possible career paths, preparing them for future employment. The period between the pilot and mature phases of WP4 will be decisive for monitoring learner experiences to select practices for learner engagement, focusing on: (1) structure vs. flexibility in learning opportunities; (2) adaptation of learning resources; (3) and augmenting impact on learning outcomes. Therefore, the pilot phase of the project aims also at enabling consortium partners to select indicators to draft a robust mechanism of risk diagnostics and reveal the strengths of SLEs in enhancing learners’ support.

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1. Introduction

1.1 Rationale

WP4 - Learner Engagement in STE(A)M Learning Ecologies (SLEs) concentrates on engaging learners in learning experiences, which need to be designed, implemented and evaluated by stakeholders in SLEs. This work package includes the following tasks: Task 4.1 – Learning paths through SLEs, which will involve a participatory pedagogical design challenge to be taken up by stakeholders in each SLE; Task 4.2 – Learners' science-oriented choices in SLEs, where stakeholders will single out learning products[1] to be constructed by learners themselves during learning activities – as long as learning products will reflect knowledge, skills and competences necessary for their construction, they will be used for evaluation purposes; Task 4.3 – Implementation of learner activities, where the participatory pedagogical designs of Task 4.1 will be implemented – this task will mirror Task 3.3 (Implementation of SLEs), in having a pilot phase with one SLE in each country followed by a mature phase with 10 SLEs in each country; Task 4.4 – Evaluation of learner engagement in SLEs, where learner engagement will be evaluated based on the learning products to be delivered by learners in Task 4.3. The present deliverable describes the methodology to be followed by stakeholders for participatory pedagogical design in Task 4.1 (Learning paths through SLEs). Since this design will have implications for all tasks in WP4, the deliverable will refer to challenges to be encountered across all tasks.

1.2 Objectives

The main objective of Task 4.1 (Learning paths through SLEs) and of this deliverable is to coordinate stakeholders in a SLE in fulfilling their major role, which is to offer learning opportunities and engage learners. Partners in the consortium most likely will not themselves produce any new learning material, which means that the learning opportunities to be offered in SLEs should be based on existing and properly adapted learning resources. Moreover, these resources should be arranged so as to produce a learning path to be followed by learners. To promote the open, constructive and iterative character of open schooling, the living labs and Design for Change approaches, on which the pedagogical design and framework of SLE rests, learners should have an active role

[1] By "learning products" we consider learning artefacts delivered by learners themselves when they undertake learning activities. Learning products can be texts, graphs, models, digital artefacts and any other product manufactured by learners using learning resources during learning activities (see in this regard De Jong et al., 2012; Hovardas, 2016a; Hovardas et al., 2018; Hovardas & Zacharia, 2019).

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in their learning experiences, be able to choose among alternative trajectories, as much as this will be possible, and be able to be creative and innovative. In order to address the above challenges in pedagogical design, stakeholders should single out and describe a set of core learning products, which will be delivered by learners themselves along their learning trajectories. These learning products will comprise the reference level for the evaluation of learner engagement. Furthermore, learning products will give the opportunity to bridge formal and non-formal/informal learning settings in SLEs by allowing for mapping knowledge, skills, and competences as reflected by learning products to curriculum standards. Last but not least, learners would need support and guidance along their learning paths, which will be provided by stakeholders in SLEs and which will be also incorporated into participatory pedagogical design.

2. Link to the SLEs methodology

2.1 Learner meaningful engagement

Learner meaningful engagement is one key dimension on which the methodological framework of SLEs is based. It will be pursued through two main components: First, STE(A)M, which acknowledges that each discipline alone cannot grasp the complexity of real-life problems, and therefore, multiple subjects need to be combined to understand problems and weigh alternative solutions. Second, the inclusion of both formal and non-formal/informal learning settings, which is reflected in stakeholder coalitions in SLEs, promotes STE(A)M but also fosters science-based careers, employability, and innovation. Learner meaningful engagement is expected to prove crucial for the sustainability of all SLEs and should be prioritized in participatory pedagogical design.[2]

2.2 Co-creation

Co-creation is a major characteristic of open schooling and the living labs approaches. It presupposes the contribution of all stakeholders when elaborating on real-world problems and advances a common vision between them when screening potential solutions. Being both a process and outcome, co-creation is instrumental in facilitating

[2] Mavromanolakis, G. Sotiriou, S. Koulouris, P. Tasiopoulou, E., & Quarta, B. (2023). The STEAM Learning Ecologies White Paper. STEAM Learning Ecologies, Deliverable 2.1. https://www.steamecologies.eu/wp-content/uploads/2023/07/SLEs-methodology.pdf.


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the development of 21st century competences, for instance, problem solving, critical thinking, and creativity. Co-creation will augment learning experiences in SLEs in a twofold manner: (1) By means of substantial stakeholder input for learning journeys and feedback provided to learners, which will be channelled through the mobilization of learning material and resources and stakeholders' own research traditions and projects; (2) Through the opportunity of learners themselves to communicate their findings and solutions to stakeholders, which is expected the perspectives of all involved actors in each SLE, their creativity as well as their potential for innovation[2]

2.3 Pedagogical design and framework

The pedagogical design and framework of SLEs will be informed, overall, by the principles of open schooling, the living labs concept, and Design for Change. Open schooling adds, among other crucial aspects, the actuality and importance of topics to be selected for initiating learning trajectories, which engages learners and the wider local community. The living labs concept highlights the need for solutions to be user-driven, realistic, and readily applicable, which is anticipated to consolidate commitment by all stakeholders in SLEs and end-users. Living labs share with Design for Change an iterative character pointing to an origin of engineering design processes, with subsequent cycles of inquiry learning aiming at investigating, exploring and optimizing solutions. Such iterations are expected to reinforce the sustainability of SLEs in the mid- and long-term.[2]

3. Learner engagement monitoring and reflection methodology

3.1 Participatory pedagogical design

The template for participatory pedagogical design to be used by stakeholders in SLEs is presented in Table 1. It includes six main themes and examples for each theme. Starting with potential learning paths, stakeholders need to first identify available learning resources and material, which learners may use. All stakeholders and learners should be aware of all available resources and have access to them. Adaptation of resources may be needed to account for specific characteristics of learner groups and proper differentiation, which should be taken over by the stakeholder coalition. Resources should then be arranged to create a learning path. This means that learners should be able to use learning resources and progress along a learning journey. To allow for flexibility in the open learning environments of SLEs, alternative routes may be designed so that learners may have the opportunity to choose different paths. This flexibility can

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be visualized in the form of decision trees. Examples in this first theme of the template for participatory pedagogical design need to refer to the basics of open schooling, the living labs, and the Design for Change approaches, which comprise the core of pedagogical design and framework of SLEs.

The next theme in Table 1 centres around learning products. These are defined as artefacts that will be created by learners during enacting learning activities (e.g., texts, graphs, models, digital artefacts, and any other product manufactured by learners using learning resources available in an SLE). Having identified learning resources/material, stakeholders in the SLE need then to describe the learning products that students can deliver by making use of learning resources. Moving to the next theme, knowledge skills and competences necessary for the construction of learning products need to be reflected in them, meaning that these qualities are presupposed for the delivery of the learning products under reference. The same qualities may be employed for a curriculum mapping task, which is expected to bridge formal and non-formal/informal learning settings in SLEs. A final note is crucial here: since we would wish learning resources to support learners in creating learning products, then this should be a top criterion for selecting learning resources and material, in the first place. At the same time, any support or guidance that learners may need along their learning path for constructing learning products (next theme in Table 1) should be offered by stakeholders in SLEs. Such a provision may be one of the most challenging aspects of participatory pedagogical design in each SLE, but it is of primary importance for securing fruitful learning experiences.

Participatory pedagogical design concludes with highlighting opportunities for female engagement and career opportunities. For the former, the selection of topics, which would attract equally males and females is decisive. Additionally, there is much added value in having female spokespersons of stakeholders in an SLE acting as role models and being somehow engaged in learning trajectories (see Zacharia et al., 2020). As far as career opportunities are concerned, positions of employees and managers at stakeholders in the SLE can be utilized (among public, private, and civil society organizations).


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Table 1 Template for participatory pedagogical design in a SLE

Main themes for participatory pedagogical design	Examples
(1) Potential learning paths (how resources can be utilized to form learning routes; decision trees based on learner choices in the open learning environments of SLEs)	To be described following the basics of open schooling, the living labs, and the Design for Change approaches[3]
(2) Learning products to be created by students themselves along learning paths	Any artefact that will be created by learners during enacting learning activities, e.g., texts, graphs, models, digital artefacts, and any other product manufactured by learners using learning resources
(3) Curriculum mapping of knowledge and skills as reflected by learning products	Correspondence of knowledge and skills reflected by learning products to curriculum standards for corresponding subjects
(4) Support and guidance to be provided by stakeholders to students along learning paths	Contact persons of all stakeholders in the SLE to be available to offer feedback for each learning product; peer feedback
(5) Opportunities for female engagement	Selection of topics that would attract equally males and females; female spokespersons of stakeholders in the SLE acting as role models
(6) Career opportunities	Positions at stakeholders in the SLE (public, private, and civil society organizations)

[3] See Mavromanolakis, G. Sotiriou, S. Koulouris, P. Tasiopoulou, E., & Quarta, B. (2023). The STEAM Learning Ecologies White Paper. STEAM Learning Ecologies, Deliverable 2.1. https://www.steamecologies.eu/wp-content/uploads/2023/07/SLEs-methodology.pdf.

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3.2 Monitoring based on participatory pedagogical design

Each theme in Table 1 may be employed to regularly revisit participatory pedagogical design, if needed, and optimize it based on prior learner experiences in SLEs. Although it will be up to each stakeholder coalition in SLE to determine the frequency and agenda of their meetings, a point in time when all SLEs should focus on monitoring should be the transition from the pilot phase to the mature phase. The task will be to go through all themes of Table 1 and report what has worked well and where stakeholders have noticed any divergence from their initial designs. Quite importantly, teacher and learner input should be sought at this stage. This monitoring process will allow for outlining good practices for learner engagement, as will be described in the next section.

A first attempt at describing core aspects of pedagogical design has been depicted in Appendices for eight different potential SLEs. These were based on input by consortium partners only and do not mean to be binding for the selection of the SLE described in the pilot phase. The cases described are, however, indicative of the aspects which should be covered in participatory pedagogical design. The tables shown in the appendices are much more detailed than the template of the Table to guide stakeholders through major dimensions of the task. Provided that the SLEs described could be chosen as pilot SLEs, the content of appendices may be enriched by stakeholders after they will be engaged in each SLE. In any case, Appendices reflect the diversity and heterogeneity both within as well as across potential SLEs.

The identified stakeholders include educational authorities, industry representatives, universities and local government officials. This collaboration enriches the learning experience by providing resources and expertise. Many of the provided SLEs offer alternative learning paths and cater to the individual preferences and interests of students. Simultaneously, several of them, emphasize real-world application by involving students in projects that address practical challenges, contributing to bridging the gap between classroom learning and real-world problem solving. Furthermore, the inclusivity of the designs of SLEs, appealing to learners of all genders, demonstrates a commitment to diversity and equal access to educational opportunities. The learning pathways that are provided align with potential career opportunities in STEAM fields. Students gain practical experiences and insights into possible career paths, preparing them for future employment.

For example, based on the potential SLE in Cyprus, this program will engage a range of stakeholders, including schools, a university, the Ministry of Education, and environmental organizations. They will all contribute diverse learning resources and engage students in activities aimed at discovering more about butterflies.

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These resources encompass the Butterfly Count app, guides, books, workshops, and natural habitats, offering students a comprehensive learning experience. Students will create various learning products, including diagrams, tables, graphs, models, maps and presentations, all aligning with the curriculum. Stakeholders will be ready to provide essential support and guidance to students. The program is designed to be inclusive and appealing to both male and female learners. Furthermore, it will introduce students to a broad spectrum of STE(A)M related career opportunities, such as in ecology, research, environmental science, education, and technology development. More information for this and other potential SLEs is listed in the Appendices.

3.3 Learning products

The description of learning products which will be delivered along different learning trajectories was already initiated in participatory pedagogical designs so that stakeholders in SLEs can have an impression of what is to be anticipated by learners. Since learning products will be the only direct proof of learner engagement and performance in SLEs, partners and national coordinators will be given concrete guidelines and will be supported on how to identify and gather learning products along learning routes. They were also supported in outlining, where possible, “expert” solutions (“expert” learning products), which are expert deliverables for the same learning tasks, in which learners will also engage in the pilot cycle.

Despite the fact that learner products constructed by learners may differ from expert solutions, the latter will offer a solid indication of learners’ range of potential science-oriented choices as well as of scientific knowledge, skills and competences necessary for their construction in SLEs (see Table 2).


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Table 2 Examples of learning products

Country	SLE topic	Examples of learning products
Cyprus	Butterflies	Transects designed for recording butterflies; butterfly counts by means of the central electronic system eBMS
Germany	Experimentation in Chemistry	Hypotheses; experimental designs; datasets
Greece	Earthquakes	Seismometers; datasets, graphs
Ireland	Science careers	Survey items and stats; sketches of Museum and microscopy lab
Italy	Circular bioeconomy	Films; articles; creative recycling solutions; Nudge experiment
Malta	Entrepreneurship and STE(A)M	Flow diagrams; entrepreneurship solutions for real-world problems
Norway	Software engineering and project management skills	Minimum Viable Products (software product); architecture, testing and risk management and any other required for the project section
Romania	Discover nature in the Cozia National Park	ebook of nature; graphs; robotic models; comics; videos; bird feeder models
Serbia	Sports equipment	Sketches of innovative sports equipment designs; digital 3D models; drawings; CAD models; mock ups showcasing the design's physical aspects and usability; datasets; graphs
Slovakia	Herbal book on endangered plant species	Field guides; portfolio with photographs; exhibition blueprint

To facilitate the collection and evaluation of both expert artefacts and learning products of pilot SLEs, an online repository has been created. This will be hosted and administered by EUN. Moving from the pilot to the mature cycle, the initial repository is envisaged to be enriched with more learning products and evolve into a comprehensive portfolio of all SLEs that will highlight learner engagement, development, and outcomes from concept to practice. The growing repository will also address multiple objectives beyond WP4, for instance, inspiration for community engagement and development (WP2 and WP3) and dissemination and communication (WP6). To facilitate such a positive spillover effect, co-creation and reflection workshops are planned in a cluster of WP2-3-4 activities on M12 and beyond every six months.

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A coding scheme for evaluating learning products has been developed, which will be optimized and fine-tuned to fit needs and desires of different contexts of implementation in the pilot cycle. Specifically, learning products will be categorized and analyzed to produce a set of indicative meta-data for each category. Based on these metadata, a coding scheme for evaluating learning products will be developed (Table 3).

Table 3 Coding scheme for evaluating learning products

Code	Description
0	Not delivered/irrelevant/out of scope
1	Incomplete, students would need to repeat the activity to complete the learning product
2	Incomplete, students could complete the learning product with a few amendments without having to repeat the activity
3	Complete, no further action required (ordinal variables)

On top of the coding scheme, a survey will be addressed to teachers and other stakeholders in SLEs to let them reflect on specifics of learner engagement (e.g. performance; motivation; self-efficacy, etc.). The results of the survey will complement coding results of learning products to develop a historical account or learners' experience. The survey will also serve as a draft protocol for conducting interviews and focus groups with selected members of stakeholders in SLEs, where participants will have the opportunity to delve deeper into qualitative aspects of learner routes in SLEs and focus on the main challenges encountered by learners and how these were dealt with, tipping points during learner engagement and their determinants, etc.

3.4 Digital recognition badges

"Digital recognition badges" will be awarded to SLE initiators, stakeholders, and learners with outstanding contributions in the pilot phase. The purpose of this is to recognize and increase the visibility of key contributors, who can then serve as peer supporters, mentors change agents and inspiring practitioners in the mature phase of the project. Such an addition will be decisive for supporting learner engagement after the pilot phase. An initial scheme of award criteria at individual or/and institutional level has been already devised and will be launched in M17. The current scheme includes the award of a digital badge and certificate to be utilized in social media, institutional websites, and dissemination material. The scheme will be expanded in the mature phase across a large number of SLEs, where higher distinction awards will be adopted to include e.g.


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attendance of key events, international conferences, professional development programmes, and summer schools.

4. Selection of good practices for learner engagement

The selection of good practices for learner engagement will be operationalized by monitoring learner experiences with explicit reference to participatory pedagogical design (see the six themes of Table 1). The period between the pilot and mature phases of WP4 should be chosen as the proper timing for this challenge. Three topics can be underlined, among many others, which can be added by stakeholders in SLEs, to structure this process: (1) structure vs. flexibility in learning opportunities; (2) adaptation of learning resources; (3) and augmenting impact on learning outcomes.

4.1 Structure vs. flexibility in learning opportunities

The interplay between structure and flexibility has marked many open-ended learning settings. It refers to learners' need for guidance (structure) so that their learning trajectories remain constructive. At the same time, it also refers to the flexibility necessary for learners to maintain initiative and control over the process, which is crucial for creativity and innovation and for promoting self-regulated learning and metacognitive awareness of the entire process and learner engagement. Striking a proper balance between structure and flexibility has always been quite a demanding and difficult task, especially in open-ended learning environments (Xenofontos et al., 2020). Input from monitoring based on participatory pedagogical design should shed more light on this interplay and reveal the circumstances under which stakeholders should opt for either structure of flexibility.

4.2 Adaptation of learning resources

The availability of learning resources should be a major criterion for inviting and including stakeholders in SLEs. The diversity that should be expected in stakeholder synthesis, the presence of public, private, and civil society organizations in stakeholder constellations in SLEs, the interplay between formal and non-formal/informal learning settings, the heterogeneity of learner groups to be expected, all point towards the need to adapt learning resources so that they are suited to the characteristics and needs of learners. Adaptation, however, may increase the workload imposed upon stakeholders


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substantially and this needs to be added to the time that they already need to allocate for providing support to learners. Therefore, finding effective ways of adapting learning resources may be of paramount importance for successful learner engagement. Monitoring based on participatory pedagogical design should include that dimension.

4.3 Augmenting impact on learning outcomes

Learning outcomes will be reflected in the qualities of learning products, as long as learning products will reveal the knowledge, skills, and competences necessary for their construction. For example, a paper-and-pencil or digital graph will reveal if all necessary variables have been included (dependent and independent variables), if data sets have been transferred properly and were properly depicted in the graph, if students attempted to fit graph points so as to infer any trends, etc. A careful depiction of learning resources, which will support learners in creating learning products along their learning trajectories will be key for learner engagement (see, for instance, Hovardas, 2016a). A last point to consider in monitoring based on participatory pedagogical design is to explore factors, which augment impact on learning outcomes. Good practices for adapting and arranging learning resources along learning trajectories, selecting and describing learning products, offering productive support and guidance to learners, and offering opportunities for female engagement and career opportunities should converge on guaranteeing positive results of learner engagement in terms of major learning outcomes. This task needs a comprehensive synthesis of many different aspects of pedagogical design mentioned above and should be a primary focus in the transition between the pilot and mature phases.

5. Implications for learners' support mechanism

In this section, we will present the basics of a learners' support mechanism (i.e., risk diagnostics and methods for the valorization of strengths), which will be developed by consortium partners after the end of the pilot cycle (one SLE in each country) and which will be based on stakeholder experiences in this first pilot phase. This mechanism will be freely accessed via the website of the project by stakeholders engaged in the mature phase of the project (10 SLEs in each country).


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5.1 Risk diagnostics

Stakeholders in SLEs should be alerted to identify risks for learner engagement and take any corrective action, if necessary. Risk diagnostics should involve a list of indicators to detect risks for the learners' support mechanism. This may include variables that may be easily recorded or documented, for example, if a stakeholder is responsive to demand for learner support or if learner support corresponds to the initial demand voiced by learners. Maintaining a vibrant and viable relationship between learners and stakeholders may sound like an ideal situation, but stakeholders in each SLE should do their best to reach as close to this ideal as they can. Examining effective ways of providing support while keeping the workload for stakeholders as minimal as possible may be an insightful way to address this challenge. The pilot phase of the project should enable consortium partners to select such indicators and draft a robust mechanism of risk diagnostics.

5.2 Valorization of strengths

The pilot cycle of the project is also expected to reveal the strengths of SLEs in enhancing the learners' support mechanisms. These may include, but not be confined to: Co-design of digital learning spaces by teachers and other stakeholders, which reinforces the positive qualities of pedagogical design (de Jong et al., 2021); inclusion of educational leadership dimensions, which are especially important for offering leaner support in non-formal environments (Hovardas, 2016b); inclusion of peer assessment, which catalyzes the positive results of collaborative learning (Vakkou et al., 2023); inclusion of gamification or game-based learning, which provides strong incentives to learners (Hovardas et al., 2023). Such strengths need to be identified and valorized based on initiating and revisiting participatory pedagogical design.

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Table 1Table 2Table 3

7. Appendices

7.1 Potential SLE in Cyprus

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	• Schools (Secondary education students and teachers) • University of Cyprus • Ministry of Education • Department of Forestry • Butterfly Conservation Europe • UK Centre for Ecology & Hydrology • Cyprus Museum of Natural History • Athalassa Environmental Center
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	• Butterfly Count app - Created by the Butterfly Conservation Europe and the UK Centre for Ecology & Hydrology • Butterfly Identification Guide from eBMS • Books (e.g. "Butterflies of Cyprus") provided by researchers • Meetings/Workshops provided by researchers, foresters of the Forest Department, and representatives of the Ministry of Education at the Athalassa Environmental Center • Butterfly park at the Cyprus Museum of Natural History
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	• Information meetings with researchers, foresters of the Forest Department, and representatives of the Ministry of Education at the Athalassa Environmental Center (instructions for using the application, classification of butterflies and plants, possible obstacles)

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	• Weather, flowering, and butterfly recording using the Butterfly Count app. The recording can take place either on a predetermined route of 200-300m or on a random route with a predetermined duration of 15 minutes. Spotted butterflies are captured with nets, photographed, and released back to their environment • Identification and classification of butterflies using the Butterfly Count app, books (e.g. "Butterflies of Cyprus"), the eBMS Butterfly Identification Guide, and with the guidance of scientific partners • Table, graph, model, and map creation based on the above data • Results presentation at the Cyprus Museum of Natural History
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	• Students can suggest different ways of presenting the results. • Students can take further action and propose solutions to local and government authorities to help increase butterfly populations.
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	Diagrams, Tables, Graphs, Models, Maps, Presentations
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	• Tables (weather, flowers, butterflies number and characteristics - data collection) • Graphs/Diagrams (data analysis) • Models (butterfly life cycle) • Maps (butterfly migration map)

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	• Presentation of results (ppt, video, etc.)
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	• Data collection tables (5-8 hours for 15mins weekly observations) • Models (2-4 hours) • Maps (2-4 hours) • Data analysis graphs/diagrams (8-10 hours) • Results presentation (4-8 hours) ---------- Total: ~ 21-34 hours
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	Meetings with experts or the number of observations could be increased.
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	• Science (animal and plant classification, butterfly life cycle, pollination, food chains, environmental problems) • Technology (use of app, results presentation) • Engineering (model construction) • Mathematics (graphs, diagrams) • Geography (butterfly immigration maps) • Skills: data collection and analysis, problem-solving, modelling design, results communication
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	• Guidance on the methodology, how to use the app, ways of classification of butterflies and plants, and solutions to potential obstacles from experts (researchers, foresters) • Teacher support during the construction of learning artefacts
11. Please indicate stakeholders who could provide this support or guidance to students.	• Teachers • Researchers of the University of Cyprus

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	• Foresters of the Forest Department • Ministry of Education representatives
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	Yes.
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	The topic is attractive to both male and female learners. Both male and female experts are encouraged to participate and interact with students.
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	• Field Scientists • Field Ecologists • Researchers • Foresters • Environmental Scientists • Environmental educators • Biologists • Museum guides • App developers • Video/Animation developers
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Participating in the program, students work as butterfly researchers. Working with experts in this field can enhance their knowledge of the above career opportunities and help them immediately solve any questions they may have about them.

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7.2 Potential SLE in Germany

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	- District mayor from Treptow-Köpenick, Neukölln Berlin - Principals - Teachers - Proferssors involved in teaching - Representative from Senate leadership for the MINT sector Berlin - Representative from Treptow-Köpenick District Office – Sustainability - Green deal (Hydrogen/Humbold Chemistry) - Coding (HU) - IRIS - The Integrative Research Institute for the Sciences Berlin - Representative from Managing Director of the Deutsche Telekom Foundation (sponsor of the ProSTEAMkolleg) - Representative from Managing Director of Innovations-Zentrum Berlin - Representative from Management of the Humboldt-ProSTEAM-Kolleg
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	- Senate Head of MINT Berlin: The Head can provide access to schools, which can serve as learning resources. This access can enable interactions with teachers, students, and administrators, allowing for potential collaborations, workshops, or educational programs within the school environment. -> berlin.link - Representative from the Treptow-Köpenick district office - is a

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	contact person and coordinator of municipal development policy. He experienced in open schooling, has already developed concepts related to open schooling. These concepts can serve as learning resources, providing guidance and frameworks for implementing open schooling practices. Through his coordination of municipal development policy, he can also facilitate access to pupils and provide valuable insights into sustainable development policy, offering additional learning opportunities. -> berlin.link2 - IRIS Adlershof is the prototype of an integrative research institute. As an integrative research institute, IRIS Adlershof provides an excellent infrastructure for interdisciplinary research. The institute's members, consisting of outstanding scientists, can serve as learning resources by offering their expertise, knowledge, and research findings. Additionally, IRIS Adlershof's collaboration with various companies and research centers can provide access to industry-specific knowledge and resources, enriching the learning experience. -> iris-adlershof.link - Representative from Telekom Foundation who is the managing director,he promoted its profile as a leading STEM education foundation.In 2015, he was a member of the evaluation commission for the federal-state report "Education in Germany". Since 2017, he has been co-spokesperson and board member

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	of the National MINT Forum e.V. In addition, the interdisciplinary Pro Mint Centre is funded by the Telekom Foundation. As the managing director of the Telekom Foundation, can provide access to the resources and initiatives supported by the foundation. The Telekom Foundation promotes STEM education and funds the interdisciplinary Pro Mint Centre. These resources can include educational materials, programs, workshops, and networking opportunities, all aimed at enhancing STEM education -> telekom-stiftung.link
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	The creation of a potential learning path using the learning resources provided can be structured as follows: 1. initial phase: - Expertise and input from representative of Senate Director of MINT Berlin. Insights into the educational landscape and the specific needs of the schools. - Access to schools to conduct initial assessments, surveys or interviews with teachers and students to understand their interests, challenges and aspirations in STEAM subjects (Mathematics, Informatics, Science and Technology). - Based on the information gathered -> Develop an overview of the learning objectives and potential focus areas for the learning pathway. 2nd Middle Phase: - Look at and adapt the open school concepts developed by the representative of the Treptow-Köpenick district office. These concepts can be used to design engaging and interactive learning activities that promote student

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	participation, creativity and problem-solving skills. - Organise a collaboration with the representative of the Treptow-Köpenick district of workshops or trainings for teachers to introduce them to the open school concepts and support their implementation in the classroom. - Access students to pilot the open school approach and provide opportunities for students to explore STEAM topics through real-world projects, hands-on experiments and collaborative learning experiences. - Monitor and evaluate the results 3. advanced phase: - Collaboration with IRIS Adlershof to extend the learning pathway with cutting-edge research, business and academic expertise. Organise guest lectures or visits to the research institute to introduce learners to interdisciplinary research, technological advances and possible career paths in STEAM fields. - Leverageing IRIS Adlershof's collaboration with the companies and research centres to provide learners with industry insights and practical applications of STEAM knowledge. This may include internships, mentoring programmes or case studies that demonstrate how STEAM concepts are applied in real-world contexts. - Incorporating resources from the Telekom Foundation, into the final stages of the learning pathway. These resources may include access to educational materials, online courses or participation in STEAM-oriented events and competitions. By designing the learning pathway in this way, learners progress gradually from initial assessment and

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	understanding of needs, through practical and open school experiences, to exposure to advanced research and industry applications, and finally to access to additional resources for further skills development, networking and career exploration.
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	No, but from the main learning path described earlier, there can be alternative ways to combine the learning resources to create different learning paths, like research-Driven Learning Path or Industry Partnership Path. By exploring these alternative paths, learners can benefit from diverse learning experiences and tailor their educational journey to align with their interests, goals, and career aspirations.
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	When employing the learning resources described earlier, learners can create a variety of learning products as part of their learning activities. These learning products can take the form of concepts maps, experiments, presentations, videos, tables with data and graphs.
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	When focusing on the topic of sustainability, learners can create Sustainability Action Plans, Infographics/plans, case Studies or Sustainable Design Projects, experimental designs or sustainable models.
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for	Experimental Designs: Developing experimental designs can take around 1 to 2 hours.

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each learning product to arrive at the total learning time for the entire learning path.	Creating data tables and graphs typically requires 30 minutes to 1 hour, depending on the amount of data to be organized and visualized. Models and Prototypes: The time needed to create models and prototypes can vary widely depending on the complexity and materials involved. During the holiday course of the last years, a sustainable car was to be built which took half a day (duration of the course). The total learning time for the entire learning path would depend on the specific combination of learning products and the pace at which learners engage with the materials.
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	The total time is less than 40 hours, but more learning products could be presented so that the total time is about 40 hours
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	Experimental Designs: - Learning Goal: Planning and executing scientific experiments. - Knowledge and Skills Required: Understanding scientific principles, formulating hypotheses, designing controlled experiments, identifying variables, and knowledge of measurement techniques. Data Tables and Graphs: - Learning Goal: Organizing and presenting data effectively. - Knowledge and Skills Required: Data collection methods, data organization and interpretation, statistical analysis, and graphing techniques.

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	Models and Prototypes: - Learning Goal: Applying theoretical concepts to practical designs. - Knowledge and Skills Required: Understanding of relevant scientific or engineering principles, creative problem-solving, modeling techniques, and proficiency in using design tools or materials. Presentations or Slideshows: - Learning Goal: Communicating information and ideas clearly. - Knowledge and Skills Required: Organizing content, visual design principles, effective presentation skills, and proficiency in presentation software.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	Clear instructions: clear and detailed instructions for each learning product, including purpose, expectations and success criteria. Complex tasks gets broken down into manageable steps to help learners with the construction process. Examples and samples: Examples or samples of completed learning products gets provided to give learners a clear understanding of the expected quality and format. The examples can serve as models for learners to follow during the construction process. Rubrics or assessment criteria: Rubrics or assessment criteria gets developed that outline the key components, such as skills and qualities, expected in each learning product. This provides learners with a framework for self-assessment and helps them understand what areas they need to focus on during production.

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	Research and resource materials: Learners are given access to relevant research articles, textbooks, online resources and other reference materials that support their understanding of the topic and guide them in creating their learning products. Peer collaboration and feedback: Peer collaboration gets encouraged by giving learners the opportunity to work in pairs or small groups. This allows them to share ideas, give feedback and support each other throughout the creation process. Peer feedback can improve the quality of learning products and foster a collaborative learning environment. Personal guidance: personal guidance and support gets provided. individual feedback is given, and questions or challenges are addressed and suggestions for improvement, tailored to the specific needs of each learner, are offered. Opportunities for reflection and revision: Learners, gets encouraged to reflect on their learning process and the quality of their learning products. Opportunities to revise and improve based on feedback received.
11. Please indicate stakeholders who could provide this support or guidance to students.	Headmaster Teachers/Doctoral students Professors involved in teaching
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	Yes
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning	Yes, the main learning path will be attractive for all genders.

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path can equally attract male and female learners.	
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	The main learning pathway, its learning activities and identified learning resources can provide a foundation for various career opportunities related to STEM subjects and sustainability, such as environmental scientist, renewable energy engineer, sustainability consultant, green building architect/engineer, data analyst, environmental educator, urban planner, researcher
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	By providing comprehensive support and guidance in the form of career mentoring, talks, networking opportunities, practical experiences (project work, internships), stakeholders can effectively reflect the identified career opportunities and help learners find their way to a successful career in sustainability and STEM.

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7.3 Potential SLE in Greece

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	The SLE that we will implement during the 1st cycle of pilot activities will be based on learning resources developed by EA
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	The learning resources include presentations, videos, technical diagrams, user guides, programming software, 3d designs, simulation packages, hardware
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	Presentations and videos will be used first, followed by diagrams, user guides and simulation, then software programming, 3d design, hardware construction and integration
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	This depends on what students decide to design and build. They will be encouraged to search for and utilize additional resources or create their owns
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	Tables with data, graphs, drawings, models, software code, 3d objects, flow diagrams, presentations, operational hardware
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	This depends on what students decide to design and build and whether they plan to present their work e.g. in school contests, exhibitions or conferences, school fairs etc. In general a sequence can be tables with data, graphs, drawings, software code,

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	models, 3d objects, flow diagrams, operational hardware, presentations
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	It is difficult to estimate time for each one. In total students will work for about 2 hours every week from Sep to May. In total it is about 50 to 60 hours
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	At the moment there is no need to omit any activity because the SLE is designed to be implemented throughout the full school year
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	The SLE for the 1st pilot cycle has and diverse links to Science-Technology-Engineering-Mathematics school curriculum topics. These include: Maths (vectors, vector analysis, solids, statistics) Physics (forces, motion, equilibrium, torque, energy, pressure, electromagnetism) Informatics (coding, software development, user interfaces) Technology (cad, robotics, engineering practices) Entrepreneurship/applications – social responsibility and ethical considerations
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	Learners will be supported and guided by the person/persons who is responsible to implement, coordinate and run the extracurricular students club of EA and the pilot SLE. And also administer the learning resources on which the SLE is based on.
11. Please indicate stakeholders who could provide this support or guidance to students.	The SLE that we will implement during the 1st cycle of pilot activities will be based on learning resources developed by EA
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	Yes

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13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	Yes the learning paths will be attractive to both male and female learners
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	Learners perform tasks like real scientists, researchers and engineers do for their everyday job, and learn and develop similar work practices and attitudes. Additional to content knowledge on subjects related to Physics, Maths, Informatics, Engineering/Technology, students during their work they improve their social and verbal skills through collaboration, communication, presentation, project planning and management. They also develop key competencies including creative learning, innovative thinking, problem solving, cross-disciplinary thinking, digital and entrepreneurial literacy, and social responsibility.
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Visit to research labs and facilities of National Technical University of Athens or of Pilot Academy, interaction with scientists, researchers, professionals, engineers

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7.4 Potential SLE in Norway

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	NTNU coordinates the process and invites external companies to serve as customers (usually IT sector, or large companies with an IT department).
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	The customer-driven course at the NTNU is a fourth-year master's degree course at the Department of Computer Science. The course aims to give the students practical experience in executing all phases of large development projects in SE. Students develop a realistic prototype of an information system on contract for a real-world customer. The proposed SLE implements a problem-based learning paradigm, where students work in a group towards a solution to a real customer's demand. All phases of carrying out a project must be covered: feasibility study, requirements specification, construction, programming, and evaluation, but emphasis must be placed on the early phases. Each group of students will be allocated a project plus a main customer representative (from the IT industry) and an internal supervisor from NTNU. Towards the end of the semester, the groups must deliver a project report in English, and hold a presentation and demonstration of the final prototype of the product for the customer, while an external examiner (censor) is present. More information and details can be found in here : drive.google.link
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which	Customers from sectors such as research, telecommunication, financial, business intelligence, health,

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learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	welfare, and the public sector submit their project proposals ahead of the course. Their role was to present problems that students can address through Soft. Eng. (SE) practices. Stakeholder (customer) participation in the course is crucial for presenting students with practical industry-like projects. Typically, the number of topic proposals is larger for our course than the expected number of teams. To ensure that the project proposals meet certain quality criteria, we perform a filtering process that assesses the projects' SE relevance. Some of the customers do not get a team for a topic they have prepared. Every group and every student, select and combine the learning resources offered to define their own learning path.
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	Every group and every student, select and combine the learning resources offered to define their own learning path
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	The main artefacts produced are: programming code, a technical report and a series of presentations and updates that are given to the customers/stakeholders throughout the semester.
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	N/A
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	This is a semester long project based and industry led course. Students' must work every week, with regular meetings with the customers.

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8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	It's 40. Some of the presentations and excess reporting can be omitted, but this will hinder students' development of soft skills and feedback/involvement of the stakeholders.
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	Students gain knowledge and practical experience in executing all phases of large development projects. They master their ability to organize and carry out large development projects, as well as document and present results to a real customer. They also gather insights into project work and how groups can be used to solve complex software engineering problems.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	Here is the support/structure that is offered : On the first customer meeting on the kick-off day, you will meet your supervisor and your customer for the first time. The group is collectively responsible for keeping the minutes of this meeting. The resume should be shared with the persons involved (group members, supervisor, customer) later the same day. Throughout the semester, you will need several weekly internal group meetings. The groups have been allocated a group room once a week, and you can find the room of your group on Blackboard. Furthermore, your group should have a main supervision meeting with your supervisor regularly. During the first pre-planned meeting, usually the next day of the kick-off day, you will have to agree upon when and where these meetings shall take place for the rest of the semester. The meetings will have group-specific content, and the advisor will also focus on the teamwork and group dynamics aspects. The meeting

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	agenda must be sent to the supervisor in advance.
11. Please indicate stakeholders who could provide this support or guidance to students.	NTNU has a dedicated web portal with a Microsoft form to make the process of collecting customers/proposals as independent as possible. The website warns about new proposals being uploaded from interested parties, with an email to the course coordinator. The portal also points to the NTNU rules for Intellectual Property Rights and informs the customers that by filling the form they accept the NTNU framework for IPR The student has the copyright to the assignment he/she writes. The course used to have a lot of rejected proposals.
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	The stakeholders sign a contract, and they have to provide guidance. There are always routines for students to change customer and role.
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	Although it is difficult to name "the main path" since students shape their path based on the customer, the industry, and the role they select, the Soft. Developer profile is attractive to both males and females. NTNU's CS dept has a good gender balance (ca. 40-60).
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	The students are introduced to the various career opportunities that exist in the IT industry. Depending the selected role as well as the customer students shape their own learning path (e.g., IT consultant, front end developer, scrum master in large software projects and so on). You can also see here the "D4.2. Technical Resources" available to students. Link.Deliverable4.2
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Stakeholders (the IT industry) support and guide students based on their experience and introduce them to

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	good practices and industry expectations. Many students find out the role they want to have when they graduate (e.g., Scrum Master, Quality manager, lead developer) and they identify potential employment.

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7.5 Potential SLEs in Romania, Slovakia, and Sweden

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	The type of stakeholders who our teachers will engage in the SLEs are teachers, parents, NGOs, experts and local authorities such as National park authorities. .
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	In the SLE in Slovakia, learning resources will revolve around the usage of AI in the form of a plant recognition app that students will use to identify rare plants in their neighbourhoods/parks/forests. Additionally, national park authorities will be invited to send an ecology teacher for outdoor activity such as a workshop on rare plants. In the SLE in Sweden, experts from Rena Mälaren (lake) will be invited to discuss the hazards faced due to human activities.
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	This will depend on the students and the educational goals to be set by the SLE stakeholders. A possible scenario is that students will initially explore fundamental concepts and ideas within the school environment. As they progress, their knowledge will be further enriched through outdoor experiences and engaging interactions with experts. They will then culminate their educational journey by creating tangible artifacts aimed at raising awareness and offering innovative solutions within their community
4. Are there any alternative ways to combine the above learning resources, apart from the	Absolutely. Learning resources can be used in a different order depending on

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main path which you have already described? Are there any alternative learning paths?	learners needs, educational goals but also stakeholders' availability in introducing them.
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	In the SLE in Slovakia, students will produce a virtual herbal book with photos plants, using the AI plant identification app. In the SLE in Romania, learners will produce a Nature Journal, Arts and Crafts with natural materials by integrating arts and crafts activities using natural materials found during the nature walks In the SLE in Sweden, students will draw a futuristic view of the lake if the lake is not taken care of, in the art classroom and will draft a scientific article on the requirements amendments necessary to save the lake ecosystem. The students can submit the posters and scientific articles in a competition and parents can attend this event.
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	The learning products will include the collection of evidence (pictures, plants) and the development of messages, info sheets, posters, communication campaign, digital books. Their order will depend on the order of the activities that will be decided by the SLE stakeholders themselves.
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	Each learning path will last between 20-30 hours.
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be	Flexible planning will allow teachers to use the remaining hours for coordinating with the other stakeholders while being able to accommodate learners' individual

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omitted, so that total time is decreased to about 40 hours?	needs by providing additional activities and guidance.
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	The design of the SLEs activities and the developed learning product are closely related to the development of skills, competences and the acquisition of knowledge that directly related to the specific national goals and curricula.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	Support can be provided by inviting more stakeholders into the activities. For example, parents, universities, artists and local government bodies could get involved in diverse ways. Parents could go on field trips with their children to work on the nature books / plant identification, artists could teach students how to draw, universities could invite students to their campuses to learn more or engage with professors, government bodies could organise events to make the students' work more impactful. Support can also be offered by planning activities that promote mentoring, peer learning and regular exchanges among the different stakeholders.
11. Please indicate stakeholders who could provide this support or guidance to students.	Answered in question 10
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	All stakeholders are committed and excited to support learners in any possible way.
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	The learning resources and products will be attractive to both male and female learners.
14. Which career opportunities are related to the main learning path, its learning activities	The career opportunities related to the learning activities and resources are:

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and learning resources, and to the learning resources which learners will use?	Pursuing science to aspire to become a botanist, biologist, or scientist. Or studying environmental sciences/conservation or politics to work for a thinktank/policy/government/non-profits in the environmental fields. Other opportunities are working in technology or big companies to work towards sustainability or creating apps/working in AI. Students could also study art and design to become artists inspired by the learning activities.
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Stakeholders such as industry could engage students in opportunities in sustainability. Policy makers and government can provide guidance by providing internship and volunteering opportunities to students to work in their interested areas. Universities can visit schools and encourage students to consider a career in botany or biology by highlighting the benefits and opportunities of such a field and provide scholarships and place importance on recruiting female students.

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7.6 Potential SLE in Ireland

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	CÚRAM, A Transition year School, Galway City Museum, Galway Atlantaquaria, School of History and Philosophy
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	CÚRAM - Teacher in Residence Learning Pack, A Transition Year School - Links to their methodology, Galway City Museum - Outreach pack, Audio guides, brochures, Galway Atlantaquaria - Links to school pack, School of History and Philosophy - Brainstorming templates
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	Each organisation can gain info from the resource provided by the other. CÚRAM, Galway City Museum and Galway Atlantaquarias' resources will be used in activity no. 1. The School of History and Philosophy brainstorming template will be used in activity 2. Each resource will be used at various stages repeatedly.
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	We will use the brainstorming templates to provide learning pathways for many STEAM organisations who will be part of this ecosystem.
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries
6. Please arrange learning products in a sequence to reflect the sequence of tasks in	concept maps Audio recordings

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the main learning path, which you have described above.	presentations tables with data, graphs, figures smaller or bigger texts notes hypotheses experimental designs drawings models blueprints flow diagrams
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	Time in hours: concept maps -6 Audio recordings - 3 presentations - 4 tables with data, graphs, figures - 3 smaller or bigger texts - 4 notes - 5 hypotheses - 6 experimental designs - 5 drawings - 3 models - 7 blueprints - 6 flow diagrams - 6
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	tables with data, graphs, figures - 3 flow diagrams - 6 concept maps -3 (reduced from 3) presentations - 2 (reduced from 4) experimental designs - 3 (reduced from 5) concept maps -5 (reduced from 6)
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	We are awaiting info from one of the school's re curriculum learning points.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	They will have mentoring and guidance from members of Galway STEAM Learning Network.

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11. Please indicate stakeholders who could provide this support or guidance to students.	Galway City Museum, Galway Atlantaquaria, CÚRAM
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	Yes
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	It will suits all genders.
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	STEAM opportunities in science communication and in medtech research and museum design
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	The stakeholders will be from organisations who work in these areas.

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7.7 Potential SLE in Serbia

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	Schools, CPN, Universities, Local NGOs, Policy institutions
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	Schools can provide the space for activities, equipment such as 3D printers, and other sorts of tools. Technical schools in particular can provide a variety of tools including specialised equipment. CPN can provide the Makers space, the space of the Science club, and various forms of specialised equipment, including 3D printers, laser cutters, wood cutters, technical equipment, etc. CPN.makerspace.link University researchers from e.g. the Faculty of Architecture, Faculty of Forestry, and the Faculty of Transport and Traffic Engineering can provide the know-how through their expertise. Faculty.of.Architecture.link Faculty.of.Forestry.link Faculty.of.Transport.link Local NGOs with the aim of improving urbanisation can contribute with their contacts, know-how and various programs that include educational activities. Finally, policy institutions can contribute with their high-level insight on urbanisation planning and infrastructure budgeting.
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	The path will be co-designed in collaboration with the students and teachers, while CPN will facilitate this process. One proposed path will lead from the school to knowledge institutions, such as other schools and/or universities. With support from local NGOs, students will be able to get

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	familiar with the democratic process of urbanisation and how to engage as active citizens in this process. Once they gather the knowledge, the path can proceed to the CPN Makers space where the students can acquire hands-on knowledge and think through the practical problems and implications of their ideas and visions. Finally, by visiting the offices of local authorities and presenting their projects, they will develop their democratic skills and gain a more thorough insight on the development of the infrastructural landscape.
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	There are multiple alternative learning paths which the students may develop in accordance with their particular interests. They may decide to visit the Faculty of Architecture prior to developing their models at the CPN Makers space, or they may decide to present their work in form of a science fair. Once they start creating their model city, they will learn what kind of knowledge they lack and we will adjust the learning resources and the path accordingly.
5. Which learning products can learners create when employing the above learning resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	The students will create visuals in form of city maps, graphical plans, blueprints, and other types of architectural material. They will also create their own model cities that will require use of 3D modelling and printing, wood cutting, construction, painting, etc., so the products will be both digital designs and material designs. Finally, they will have their work presented in various forms, so they will have both material and digital presentations of their work. They will create their own policy briefs based on their work to suggest to the local authorities how they can be enhance the city's urban infrastructure.

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6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	1. City maps, graphical plans, blueprints 2. 3D models and prints, woodwork, paintwork 3. Presentations, policy briefs
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	The time will greatly depend on the coherence of the group, the time of the year when the activities will be implemented, as well as the availability of the learning resources. Approximate times are: 1. from 2 weeks to one month to acquire knowledge and skills 2. from 3 weeks to 1.5 months to create the learning products 3. 1-4 weeks to present the learning products
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	The total workload for the students should be around 40-60h. Students should spend no more than 4 hours per week working on the project.
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	In the first part of the learning pathway, learners should have the knowledge of the urbanisation process in all its relevant aspects (traffic infrastructure, housing, water supply, electricity, greenery, etc.). Once they start working on their models, they should have hands-on practical knowledge in order to materialise their ideas through 3D modelling, woodwork, cutting, painting, designing, etc. Finally, they should have presentation skills along with democratic and rhetorical skills in order to present their work and make it more visible to relevant entities.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	Students will most probably need training support for using the Makers space equipment. They will also need support for the enhancement of their democratic skills, while they will be in need of relevant technical guidance in

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	the phase of urbanisation development.
11. Please indicate stakeholders who could provide this support or guidance to students.	CPN will provide support in terms of offering the training for students to learn how to use the Makers space equipment. Local NGOs can offer support for the enhancement of their democratic skills, while university researchers can provide them with relevant technical guidance.
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	Yes
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	The main learning path should be equally attractive to both male and female students, although not all parts of the process may be equally attractive. E.g. girls may enjoy the design process more than boys, while boys may enjoy the construction process more, which is expected based on the gender norms that are still visible in Serbian culture. However, these activities are gender-neutral as all students are citizens that are equally affected and responsible for participating in the democratic processes.
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	From the main learning path, students become more familiar with the careers that require design, 3D modelling and printing, and engineering, which are all essentially STEAM skills of the 21st century. These skills lead to a variety of career opportunities from the design landscape, architecture, as well as engineering. With the enhancement of their democratic and social skills, students are also provided with opportunities to develop their careers in the public sector, as well as the NGO sector. By learning how to present their product, their entrepreneurial skills are also advanced, which provides them with a wide range of STEAM career

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	opportunities, especially in the startup community.
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Stakeholders may serve as role models that the students can look up to and learn from. They may discover new career opportunities that were not previously known to them by engaging in conversations with the stakeholders. In order to serve as role models, stakeholders need to be open for leading these conversations and be prepared to answer the students' questions, as well as guide them through the learning path. CPN will provide hands-on training that is usually not available to students in their regular school surrounding, which will assure more opportunities for them in their STEAM career development.

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7.8 Potential SLE in Italy

Aspects to be addressed in participatory pedagogical design	Examples in the potential SLE under reference
1. Please list the stakeholders in the STEAM Learning Ecology who can contribute learning resources.	• ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development • ENI Versalis, Versalis SpA, Chemicals company • WWF One Planet School, World Wide Fund for Nature educational portal • ISPRA, the Italian Institute for Environmental Protection and Research, ISPRA • ReSOIL FOUNDATION • Biblioteche di ROMA, Municipal public network of libraries (Rome) • APRE, Italian Agency for the Promotion of European Research
2. Please describe these learning resources, the corresponding stakeholder who can offer each one of them and please provide relevant links/references.	• APRE: books, experiments and educational toolkits to teach about the bioeconomy and bio-based products from Horizon2020 projects transition2bio.link transition2bio.bioeconomy.link • ENEA: games and recreational activities and readings on the circular economy, recycling and reuse: Enea.link eai.enea.link • ENI Versalis: games, workshops on bioplastics and their life cycle; and composting allascopertadelmaterbi.link allascopertadelmaterbi.lab_sacchetto.pdf • ENI Versalis: Educational tools and edutainment activities to encourage sustainable behaviors (questions and experiments to get to know a biorefinery, alphabet exercise): novamont-scuola.link • WWF One Planet School: video pills on the bioeconomy and on regeneration of soil oneplanetschool.link • ISPRA Ambiente: classroom activities,

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	educational excursions and guided tours, and videos: isprambiente.link • ReSOIL FOUNDATION: videos, slides, games, training cards and toolkits for teachers: resoilfoundation.link oneplanetschool.link • Biblioteche di ROMA Environmental readings: bibliotechediroma.link
3. Please describe how the above learning resources can be arranged to constitute a potential learning path for learners. Which learning resources should be used first, and in which learning activities? Which resources should be used in the intermediate part of the learning path and which at the end?	Phase 1: Co-ideation and problem exploration (October – November 2023) Students are educated on the opportunities of the bioeconomy/circular economy and how it connects with their lifestyle. Introduction to the bioeconomy, its possibilities, its sectors through interactive methodologies. 6 Informative and interactive modules on the circular economy/bioeconomy, led by researchers and experts: • The circular economy toolbox: Learning about sustainability through games and playing (ENEA) • Composting and biodegradability of products (ENEA/ENI Versalis); Experiments with natural colors (APRE) • The sea ecosystem and oceanic posidonia (ISPRA) • Knowing and preserving the soil: videopills (WWF One Planet School/RESOIL FOUNDATION) • Questions and experiments to get to know a biorefinery (ENI Versalis) • Games, workshops on bioplastics and their life cycle (ENI Versalis/APRE) Phase 2: Exploration (December – February 2024): In this phase, students are asked to design and implement possible educational materials/resources that respond in a practical way to the challenge identified through the use of bioeconomy principles. Creative workshops, data collection activities and class work with teachers will be used for

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	the design and creation of these educational artifacts (sheets, questionnaires, presentations, articles, drawings, artworks, videos, etc.). Phase 3: Experimentation, educational excursions and guided tours (March - April 2024): In this phase, the goodness of the educational products to be developed is experienced. Furthermore, two educational excursions will be organized to learn about study/career opportunities in the sector, and to get to know the life cycle of a bio-product first-hand: • Bioplastics: visit to a biorefinery, "discovering MaterBI", the life cycle of bioplastics (at ENI Versalis) • Guided visit to the ISPRA research centre Phase 4: Evaluation and dissemination (May 2024) “Students as disseminators": discussion and reflection on the success of the ideas developed. In this final phase, readings on an environmental theme and final presentation of the educational path and product (through performances/readings) will be organized at: • BiblioPoint (LIBRARIES of Rome) • After school MATEMù, with the boys and girls of the after school project (Municipio I)
4. Are there any alternative ways to combine the above learning resources, apart from the main path which you have already described? Are there any alternative learning paths?	The readings foreseen at the end of the learning path could be anticipated in the co-ideation phase. Also, the hands-on experiments (producing bioplastics and natural colors) could be postponed at the end of the theoretical part. Finally, the educational visits to industries and research centers could be organized prior to the exploration phase to give students stimuluses on the bioproducts and learning products to create.
5. Which learning products can learners create when employing the above learning	Students will create educational artifacts and material particularly during the co-

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resources? A learning product is any artefact, physical or digital, which learners can construct themselves during learning activities and when using learning resources as reference material (e.g., smaller or bigger texts, notes, concept maps, hypotheses, experimental designs, tables with data, graphs, figures, drawings, models, blueprints, flow diagrams, presentations, documentaries, etc.)	ideation and exploration phases of the living lab. During the co-ideation phase, students will produce hands-on products from small experiments to learn the principals of the circular and bioeconomy, such as bio-plastic productions, drawings/art work done with bio-based materials and natural products and texts/sheets that respond to the questions and tools given by experts. During the exploration phase, students will be involved in a practical activity/project. At the beginning of this phase, to identify the problem/issue to work on, students may conduct a mapping inquiry based activity on the bioeconomy consumptions habits in the local area and the school (e.g. with videos, surveys or interviews). Students can decide to tell their daily relationship with the bioeconomy in a simple, clear and innovative way, through articles, drawings, representations, works of art or videos. The aim is to sensitize other young people, telling in an innovative way how the bioeconomy is applied in their daily life, at school and/or neighborhood/city and how the bioeconomy can be important for their future. Furthermore, students may produce projects to explain to classmates and families what circular bioeconomy means, what bio-products are, through practical examples or multimedia material (video) that can stimulate behavior, purchasing choices, changes in daily habits, lifestyles in line with the principles of the circular bioeconomy capable of reducing man's impact on the environment and climate change. Finally, students can also choose

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	whether to create/present an example of a bio-product, which uses raw materials of biological origin, recovering the material in a circular manner and describing the entire life cycle of the product. The aim is the creation of a practical solution/new educational material on the subject of the bioeconomy that can be replicated and reused in other contexts as well: for example, explaining through educational cards how to transform organic biomass to create new sustainable products in the classroom or at school (" waste to products"), produce an educational tool to educate other young people ("eco game"), create a raising awareness of the circular economy in schools (e.g. through sticking, photos, drawings, etc.).
6. Please arrange learning products in a sequence to reflect the sequence of tasks in the main learning path, which you have described above.	Educational sheets and hands-on experiments – Realization of drawings/artistic work with natural products and bioeconomy principles - articles writing/inquiry data collection – creation of videos/posters– bio-based product design and realization/awareness raising campaign at school.
7. How much time do you believe it will take learners to construct each of these learning products? Please add the time needed for each learning product to arrive at the total learning time for the entire learning path.	To construct all these learning products, learners will take around 8 months.
8. Is total time less or more than 40 hours? If it is less, can you think of any additional learning products so that the total time is about 40 hours? If it is more, can you think of any learning products, which could be omitted, so that total time is decreased to about 40 hours?	I believe the time to conduct all the living lab will be more or less 40 hours. Each phase of the living labs will comprise around 10 hours.
9. Can you use the learning products you identified as a reference base for anchoring the main learning path in the curriculum? Please identify which learning goals or	Connection not only to STEM (environmental sciences, ecology, life cycle) but also to philosophical reflection on responsibility and on the relationship

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curriculum standards can be reflected on the learning products as knowledge or skills necessary for the construction of these learning products. Learners should have "this" knowledge and "these" skills to be able to construct "this" learning product.	between man and nature. Objectives: fostering active citizenship; agency, responsibility, autonomy, entrepreneurship; teamwork; self-esteem and resilience. Through the educational path, students will learn the reuse of biological resources, the production of bio-products in a sustainable key and to implement sustainable behaviors to protect the environment, biodiversity and ecosystems. Furthermore, the curriculum also aims to combat gender stereotypes in STEM subjects, to make STEM learning paths inclusive and stimulating, and to integrate arts and creativity into science studies. Through the living lab, students create innovative educational resources that can be replicated in other contexts, thus the school becomes a promoter of the dissemination of sustainable and circular models and actions. Educating the younger generations in behaviors inspired by the bioeconomy is the first step in changing lifestyles towards sustainable consumption models. The aim is to lead to greater responsibility, motivation to students by developing knowledge, critical and creative thinking regarding the daily use of the bioeconomy and circular economy principles.
10. Can you think of any support or guidance which should be offered to learners so that they will be able to construct the learning products you identified?	The course will involve a lower secondary class from the I.C Guicciardini (Rome). The Living Lab will take place over 8 months (between October and May 2024), in four phases, with the involvement of teachers, students, and external support researchers, entities/experts, who will inspire and guide students in order to develop autonomy of their learning pathways.

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11. Please indicate stakeholders who could provide this support or guidance to students.	Research experts, industry representatives, SLEs APRE support staff, and teachers.
12. Are the stakeholders you identified for learner support and guidance willing to provide that help?	The stakeholders identified are willing to provide the help through their expertise (ENEA, APRE, and I.C Guicciardini are confirmed). Other stakeholders are still to be formally involved and committed to the project.
13. Please consider if the main learning path you described will be attractive to both male and female learners. If not, please consider any adaptations needed so that this learning path can equally attract male and female learners.	Involving female students in the activities, and using a gender-neutral language in all presentations and work will enable to towards the reduction of gender learning gap and careers in STEM subjects.
14. Which career opportunities are related to the main learning path, its learning activities and learning resources, and to the learning resources which learners will use?	Researcher; bio-industry; bioeconomy practitioners. Students will work like real bio-economists do for their everyday job and learn and develop similar work practices and attitudes. They also practically are inspired by working along with research and industry experts, and being inspired on the future jobs that the bioeconomy can offer.
15. Please consider how stakeholder support and guidance to learners can reflect the above career opportunities.	Field visits to biorefineries/bioindustries and research centers are foreseen. Also, conducting hands-on labs and workshops with experts will stimulate students by working hand in hand with them.

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