STEAM LEARNING ECOLOGIES

# ECOLOGIES MONITORING AND REFLECTION METHODOLOGY

## Deliverable 3.1



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| D3.1 Ecologies Monitoring and Reflection Methodology | | | |
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# Executive Summary

The present deliverable describes the methodology in Task 3.4 - Monitoring and reflection on SLEs, which will allow stakeholders to reflect on both strong and weak points of SLEs and evaluate their operation based on stakeholder input. Monitoring and reflection will involve general characteristics of SLEs and a process of participatory scenario development. SLEs' general characteristics include: (1) Type and number of stakeholders involved; (2) previous experience in open schooling and the living labs approaches; (3) coordination process; and (4) action plan.

The participatory scenario development procedure will result in scenarios as storylines of future developments, based on what can be expected given certain drivers (i.e., stakeholder input and recourses to be invested). For each SLE key item, as shown in the first column on the left of Table 1, there are three scenarios to be described to steer stakeholder investment and take corrective action whenever needed. A business-as-usual scenario refers to current conditions (baseline conditions) and provides a projection of these conditions in the future provided that there is no additional investment foreseen by stakeholders. Small-effort scenarios describe what can be achieved based on minimal input and resources. Change and improvement secured after small-effort are quite crucial since they: (1) demarcate a clear departure from baseline conditions (the business-as-usual scenario); and (2) show that this was possible even under small-scale inputs. Given that the constructive dynamics of SLEs may be set in motion with relatively confined stakeholder contribution, even more improvement could be expected under more investment. Best-case scenarios portray ideal futures under optimal stakeholder investment. Best-case scenarios should involve the prerequisites for an effective operation of SLEs as well as the aspects which could secure the sustainability of SLEs in the long-run, even after the project lifetime expires.

A major implication of Task 3.4 (Monitoring and reflection on SLEs) will be to provide all necessary input so that SLEs can be improved along various dimensions. In order to fulfil this mission, Task 3.4 and the methodology presented in this deliverable need to be unfolded in parallel with the other tasks of WP3, so that: (1) stakeholders can take initiative planning their interaction and intervention for initiating and supporting SLEs; (2) stakeholders can make use of the outcomes of their collaboration to evaluate SLEs and take any corrective action, if necessary; (3) stakeholders can identify good practices which should be sustained and further enriched to secure the long-term viability of SLEs. The proposed methodology is procedure-based so that it can be easily implemented in different contexts. However, it also refers to concrete items and criteria, which will allow for a thorough comparison between different SLEs.

Consortium partners will analyze all data recorded in the pilot cycle (e.g., SLEs' general characteristics, participatory scenario development) to identify good practices for SLEs. These should guide effective stakeholder planning, joint action, and reflection and they should provide an invaluable toolkit for SLEs in the mature cycle. The template for participatory scenario development will be used for gathering, structuring, and analyzing such input to guide stakeholder interaction and risk management in SLEs. SLEs' general characteristics and stakeholder input in the template of participatory scenario development in the pilot cycle will also provide data for risk diagnostics and valorization of strengths with regard to SLEs' support mechanism in the mature cycle.

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# 1. Introduction

## 1.1 Rationale

WP3 - STE(A)M Learning Ecologies (SLEs) focuses on the facilitation of exchanges between stakeholders and their networks in order to develop and implement SLEs. This work package includes the following tasks: Task 3.1 - Co-creation of SLEs, which will deliver, among others, the vision and action plan of each SLE; Task 3.2 - Facilitation of SLEs, which will involve stakeholder synergies and mentoring across stakeholder groups; Task 3.3 - Implementation of SLEs, which will include the implementation of SLEs first in a pilot and then in a mature cycle; and Task 3.4 - Monitoring and reflection on SLEs, which will allow stakeholders to reflect on both strong and weak points of SLEs and evaluate their operation based on stakeholder input. The present deliverable describes the methodology in the latter task which will be employed to monitor and reflect on SLEs, by making use of stakeholders' feedback structured around a procedure of participatory scenario development.

## 1.2 Objectives

A major goal of Task 3.4 (Monitoring and reflection on SLEs) is to provide all necessary input so that SLEs can be improved along various dimensions. In order, to fulfil this mission, Task 3.4 and the methodology to be presented in this deliverable need to be unfolded in parallel with the other tasks of WP3, so that: (1) stakeholders can take initiative, planning their interaction and intervention for initiating and supporting SLEs; (2) stakeholders can make use of the outcomes of their collaboration to evaluate SLEs and take any corrective action, if necessary; (3) stakeholders can identify good practices which should be sustained and further enriched to secure the long-term viability of SLEs. The methodology will be procedure-based so that it can be easily implemented in different contexts. However, it will also refer to concrete items and criteria, which will also allow for a thorough comparison between different SLEs.

# 2. Link to the SLEs methodology

## 2.1 Partnership

Partnerships comprise one of the key dimensions of SLEs, on which the methodological framework of the project rests (Mavromanolakis et al., 2023). SLEs are meant to be empowering both for the stakeholders who take part in them as well as for learners who engage in the learning trajectories. For stakeholders, their coalition, synergies, and mentoring can enlarge their scope for learning and showcase how stakeholders can complement each other and enrich learning paths. For learners, their engagement in SLEs should be reflected in concrete learning outcomes in terms of new knowledge

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gained and new skills acquired, and it will provide them with the competences needed to address real-world challenges. The empowering character of SLEs offers especially schools a prominent role in acting both as a main stakeholder in initiating ecologies as well as a main education provider engaging learners in productive learning pathways through public, private, and civil society actors.

Education providers in SLEs may be formal and non-formal, offering multiple opportunities and open schooling initiatives. The latter can foster exchange between schools, the local community, academia, and enterprises, anchoring learning experiences in real-world settings. In this regard, learning benefits are multi-lateral and do not only pertain to a unidirectional flow of new knowledge and skills from supposedly knowledge "owners" to supposedly knowledge "users". Indeed, mentoring between stakeholders in an SLE encourages an interplay of science, technology, research, and innovation. Learners engaged in SLEs take advantage of a co-creation process characterized by a surplus of 21st century competences, primarily, problem solving, critical thinking, and creativity. Analogous features and advantages have been underlined in the living-labs literature (Aguirre et al., 2021), which presents another methodology that informs the establishment and operation of SLEs and builds on diverse partnerships for co-creation and user engagement.

Local partnerships evolving to effective SLEs may elevate schools to local innovation hubs and bridge the gap between formal and non-formal education as well as between the public and the private sector including the enterprise world. Such developments may lead stakeholders, especially schools, to expand beyond their own institutional confines with considerable implications for everyday school practice and educational leadership. Under the concept of SLEs, learning objectives and outcomes span over a continuum for all actors involved. Initiating an SLE, stakeholders have to discover the multiple and complex relationships that are possible in the stakeholder coalition, and many of which cannot be known in advance. In the consortium's vision for SLEs, STEAM education meets open schooling and living labs to outline learning tracks that wish to transcend curriculum confines and offer a science learning continuum for all citizens and students engaged.

## 2.2 Co-creation

Co-creation is one of the distinguishing features of the vision of SLEs within an open schooling environment, which will inform the establishment and operation of SLEs learning paths. Co-creation signals the participatory and inclusive character of SLEs, as it will be reflected in stakeholder collaboration to foster learner meaningful engagement. For co-creation to occur, there are several competences needed as prerequisites, and the same competences are enhanced as an outcome of the process, predominantly, 21st century skills like problem solving, critical thinking, and creativity. The same qualities and dimensions have been stressed as an indispensable core for the definition of living labs, inscribed within a user-driven approach striving towards novel solutions and innovation. The living lab concept adds to the co-creation an iterative character, with cycles of prototyping, testing, and optimizing solutions building on engineering design processes. Such iterations are not only purposed for learners but for all stakeholders

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involved which aligns with the monitoring and reflection methodology which will be described in the next sections.

# 3. SLEs' general characteristics

All SLEs will be first analysed to describe a set of general characteristics. These will involve: (1) the type and number of stakeholders involved; (2) their previous experience in open schooling and the living labs approaches; (3) the coordination process between stakeholders in the SLE; and (4) the action plan depicting the major aspects which will guide stakeholder concerted action. The collection and analysis of these general characteristics will offer the opportunity for a deep exploration of the background characteristics of SLEs which may determine the course of action to be taken and learner engagement. Concentration on the general characteristics of SLE will furthermore enable the identification of potential factors that may lead to progress or stagnation in stakeholder interaction and learner engagement. Project partners will be responsible for collecting these data in the pilot phase, while templates will be delivered to initiators[1] of SLEs for continuing data selection in the mature phase. General characteristics described in this section will be monitored throughout the project and data will be kept in a database which will be updated regularly.

## 3.1 Type and number of stakeholders involved

Type and number of stakeholders will be recorded, for instance, if stakeholders are: (1) public, private, or civil society organizations; (2) formal or non-formal education providers.

## 3.2 Previous experience in open schooling and the living labs approaches

Previous experience of stakeholders in open schooling and the living labs approaches will be documented, including also, their specific engagement in any co-creation processes.

[1] One of more stakeholders who took the initiative to establish a SLE and attract more stakeholders can be characterized as "initiators"; see also next section titled "3.1 Type and number of stakeholders involved".

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## 3.3 Coordination process

The coordination process in an SLE should be described, namely, how stakeholders will communicate and interact regularly, how decisions will be taken, if needed, and how emergencies and crises will be handled.

3.4 Action plan

Each SLE should deliver an action plan with the major objectives, main tasks to be undertaken by stakeholders, available resources, and a time plan for implementation and evaluation.

# 4. SLEs' monitoring and reflection methodology

In this section, we will present the methodology which will be employed to monitor SLEs and reflect on stakeholder interaction, while implementing SLEs. The methodology builds on participatory scenario development, which is a structured process of elaborating the course of stakeholder collaboration based on the resources to be invested. A hypothetical list of key items for participatory scenario development is used as guidance.

## 4.1 Participatory scenario development

Participatory scenario development has been widely used to explore possible futures for addressing complex problems (Kok et al., 2015), when considerable stakeholder input and contribution is necessary (McBride et al., 2017). Scenarios are drafted as storylines of future developments, based on what can be expected given certain drivers (i.e., stakeholder input and recourses to be invested) (Haatanen et al., 2014). The primary objective of scenarios is not so much to be perfect in their forecast but rather to let stakeholders effectively interact to mobilize and invest resources to achieve shared goals (see in this regard Bizikova et al., 2010; Planque et al., 2018).

Scenarios will allow stakeholders to plan and monitor stakeholder joint action. Specifically, they will enable them to allocate input and resources as efficiently as possible and take corrective action, whenever needed. Participatory scenario development allows for social learning to emerge, where stakeholders and engaged in joint action to form communities of practice and reflect upon their collaboration to change baseline conditions (Hovardas, 2020; Thorn et al., 2020). Change needs to be traceable and verifiable as an improvement of any reference levels. The process is expected to let stakeholders assume ownership of developments in SLEs and, thereby, facilitate stakeholder commitment and empowerment as well as the sustainability of SLEs (see in this regard Reed et al., 2013; Nilsson et al., 2021).

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Scenarios should be prepared and regularly revisited based on comprehensive stakeholder input. For SLEs, this will need to be tightly linked to all tasks of WP3 (STE(A)M Learning Ecologies), starting from T3.1 (Co-creation of SLEs), when elaborating on the vision and action plan of each SLE, moving on to T3.2 (Facilitation of SLEs), when facilitating stakeholder synergies and mentoring, and eventually, in T3.3 (Implementation of SLEs), when consolidating stakeholder interaction first in pilot SLEs and then in mature SLEs. Scenarios can be initially prepared in Task 3.1 and then regularly revisited in Tasks 3.1, 3.2, and 3.3. This implies that Task 3.4 (Monitoring and reflection on SLEs) may be conceptualized as running in parallel with the other tasks, structuring stakeholder input, and offering opportunities for reflecting upon their joint action to establish and operate SLEs.

The template for participatory scenario development is presented in Table 1 with a hypothetical list of key items. We need to highlight that all content is fictional and provided for purposes of explaining the rationale and objective of the process, only. However, some of the items and points included in Table 1 may be brought up during stakeholder interaction in the tasks of WP3. Reading the table from the first column on the left, there is a list of key items to be outlined by stakeholders. Items can be merged, added, or removed from this list, based on how stakeholders will monitor their interaction in consolidating SLEs. Usually, the items that will attract the most stakeholder discussion will be the ones to concentrate on for monitoring and reflection purposes.

For each item in the first column on the left, there are three scenarios to be described to steer stakeholder investment and take corrective action whenever needed. A business-as-usual scenario refers to current conditions (baseline conditions) and provides a projection of these conditions in the future provided that there is no additional investment foreseen by stakeholders. This scenario will be used as a reference base to evaluate change and improvement in the course of the project. Two points should be underlined here: First, after change and improvement have been observed for an SLE, a new business-as-usual scenario needs to be devised to demarcate the new baseline conditions and strive for additional improvement. Second, there can be SLEs with more or less stakeholder interaction prior to their involvement in the project. This may mean that different SLEs may have different departure points. However, each one should be evaluated and monitored based on the reference levels to be drafted by stakeholders in the business-as-usual scenario.

Small-effort scenarios describe what can be achieved based on minimal input and resources. Change and improvement secured after small-effort are quite crucial since they: (1) demarcate a clear departure from baseline conditions (the business-as-usual scenario); and (2) show that this was possible even under small-scale inputs. Given that the constructive dynamics of SLEs may be set in motion with relatively confined stakeholder contribution, even more improvement could be expected under more investment. At this point, we should note that improvement should not necessarily be anticipated anytime stakeholders would be willing to invest minimally to supporting SLEs. What the small-effort scenario wishes to outline is the cases, where concerted stakeholder action could lead to better futures, even when stakeholder investment has been sub-optimal.

Best-case scenarios for each item in the first column of Table 1 on the left portray ideal futures under optimal stakeholder investment. Best-case scenarios should involve the

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prerequisites for an effective operation of SLEs as well as the aspects which could secure the sustainability of SLEs in the long-run, even after the project lifetime expires. Ideal scenarios should narrate input, resources, and conditions for unimpeded stakeholder interaction, synergies, and mentoring. Even if the futures of these best-case scenarios do not seem readily obtainable, they nevertheless sketch what is currently desirable.

Taken together, the three scenarios offer a complete heuristic for monitoring and reflection across all items of the first column of the template. Business-as-usual presents the current conditions that need to be improved and should include all these crucial gaps and inconsistencies that should be tackled for change to occur. Small-effort scenarios correspond to change and improvement possible under relatively confined input and resources. Although small in scale, such effort is crucial in terms of impact and implications and should inform good practices for SLEs establishment and operation after the pilot cycle of the project has been concluded. Best-case scenarios point to ideal conditions, which may be unrealistic to achieve at least in the short-term. However, these ideal scenarios are instrumental in driving stakeholder interaction to productive pathways when small-effort scenarios have been accomplished.

All content of participatory scenario development should be provided by stakeholders acting locally to initiate an SLE and foster learners' meaningful engagement (see WP4 – Learner engagement in SLEs). This monitoring and reflection method is procedure based, and therefore, it can be applied in different contexts with SLEs of different synthesis and focus. At the same time, however, it will enable comparison between different SLEs both in the pilot and mature phases, especially in the transition from business-as-usual to small-effort scenarios. Such transitions will be decisive for determining good practices in the pilot phase and then building on these good practices during the mature phase of the project. Major lessons learnt in the pilot cycle and major strengths and weaknesses observed should guide stakeholder coalitions in the SLEs of the mature cycle.

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Table 1. Template for participatory scenario development with a hypothetical list of key items

| | **Business-as-usual scenario** (baseline conditions, crucial gaps and inconsistencies to address when implementing SLEs) | **Small-effort scenario** (small-scale inputs potentially decisive for achieving considerable progress in the short-term) | **Best-case scenario** (ideal conditions for SLEs to flourish and secure long-term sustainability) |
|---|---|---|---|
| Stakeholder synthesis | Schools or other stakeholder initiating educational interventions which do not result in networks | Heterogeneous networks; formal and non-formal STEAM education providers; civil society; industry partners | Heterogeneous networks which are growing (attracting more stakeholders) |
| Stakeholder interaction | Stakeholders interact infrequently or not at all; the initiator usually takes all initiative | Participation in the SLE consolidates stakeholder interaction (added value) | Stakeholders assume ownership of the process; no need for an external facilitator |
| Learning resources available | Learning resources offered to learners in a scattered/fragmented manner | Available resources aligned to create learning paths; learning aimed to result in change | Learning products described and delivered; “dynamic” curriculum mapping in place |
| Support provided to learners | Learner support not depicted in the organizational structure of stakeholders | Contact persons of stakeholders available for offering support to learners | Learner support taken into account for optimizing learning resources |

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Going back to Table 1, stakeholder synthesis has been identified as the first item in the first column on the left. For the business-as-usual scenario, stakeholder synthesis may not even comprise a network, if it is always schools or other initiators that take the initiative to start educational interventions. In such cases, fragmentation and limited resources obviously do not allow for any initiative to be sustained. Under the small-effort scenario, however, heterogeneous networks are formed, which may include formal and non-formal STEAM education providers and civil society actors. This may be often the case when schools or teachers take part in European projects and provide the opportunity of networking. Ideal conditions for this item (best-case scenario) may envisage a growing network with heterogeneous synthesis, for instance, when a school has been established as an innovation hub in the neighbourhood and beyond.

The next item in Table 1 is stakeholder interaction. Here a frequent phenomenon, which can be a business-as-usual scenario, is that stakeholders interact very rarely if at all. Another aspect of undesirable baseline conditions is that stakeholder interaction or most initiative, overall, is launched by the initiator of a SLE. A departure from this reference level in terms of stakeholder interaction (small-effort scenario) is when a stakeholder participating in any event within the frame of a SLE will acknowledge the added value of their participation and will be willing to sustain their engagement. The best-case scenario for stakeholder interaction, and one that would be optimal for the mature cycle of the project, will be that stakeholders in SLEs assume ownership of the process and do not need any external facilitator (e.g., project partner) to coordinate them.

Availability of learning resources is the third item example in the hypothetical content of Table 1. Under a business-as-usual scenario, learning resources may be offered to learners in a scattered/fragmented manner, without being arranged in learning activity sequences. Investing limited resources, stakeholders may collaborate to use available learning resources to create learning paths for learners. A best-case scenario for learning resources can be that concrete learning products are described by stakeholders and delivered by learners. By “learning products” we describe 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. Based on learning products, a “dynamic” curriculum mapping can be attempted, where each learning product is linked to curriculum standards based on learner knowledge and skills which are indispensable for its construction.

Support provided to learners is the last item of Table 1. A business-as-usual scenario in this case may involve stakeholders who have not recognized learner support as a task to take over and have not integrated it into their organizational structure. Under these conditions, no stakeholder member is responsible for offering learner support. In a small-effort scenario for learner support, contact persons for each stakeholder group may be identified, who would provide support to learners upon demand. In an ideal future (best-case scenario), stakeholders may capitalize on learner support to optimize the learning resources they can offer. This can be operationalized when screening and categorizing learner demands for support, prioritizing them, e.g., in terms of frequency and

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importance for creating learning products, and exploring ways to integrate such support at least partially in the learning resources offered to learners.

# 5. Selection of good practices for SLEs

Consortium partners involved in Task 3.4 (Monitoring and reflection on SLEs) in WP3 (STE(A)M Learning Ecologies) will analyse all data recorded in the pilot cycle (e.g., SLEs' general characteristics, participatory scenario development) to identify good practices for SLEs. These should demarcate effective stakeholder planning, joint action, and reflection and they should provide an invaluable toolkit for SLEs in the mature cycle. The template for participatory scenario development will be used for gathering, structuring, and analysing such input.

## 5.1 Stakeholder interaction

Good practices should concentrate on how stakeholder interaction can be as beneficial as possible both for the strengthening of partners' interrelations in an SLE as well as for learner engagement and fostering desirable learning outcomes. It will be insightful to see, for instance, if certain stakeholder relations are strengthened and when as well as the position and role of initiators as the development of the SLE unfolds. A control with type and number of stakeholders will be also interesting in this case, for example, if any relations between types of stakeholders are strengthened or if the number of stakeholders has any effect on the characteristics of the network. Although a fully fledged social network analysis may not be possible or even useful, identifying propensities or trends will be quite illustrative of how stakeholder networks evolve in SLEs and how such traces can be utilized to outline good practices for SLEs.

## 5.2 Risk management

Risk management will be taken over by consortium partners and it will focus on the identification, assessment, and mitigation of threats to the SLEs. In line with critical risks singled out for the implementation of the project, stakeholders may not have the same endorsement of SLEs and may not show the same enthusiasm and commitment in the process. Declining stakeholder interest may be a major risk to be acknowledged and addressed in the monitoring and reflection process of SLEs. Other risks may involve instances of bottlenecks, for instance, when increased demand by learners cannot be satisfied by supply available by stakeholders (e.g., when demand for outdoor learning opportunities cannot be locally satisfied by available stakeholder groups) or feedback loops, for example, when the outcome of a process catalyses the process itself (e.g.,

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decreasing stakeholder involvement or commitment in the SLE leads to decreasing learner engagement).

# 6. Implications for SLEs' support mechanism

A crucial difference between the pilot and mature phases of the project will be that the support of consortium partners in the mature phase cannot be as intense or as frequent as it will be in the pilot phase, due to the relatively increased number of SLEs in the mature phase (10 SLEs in each country vs. one SLE in the pilot phase). What is more, the sustainability of SLEs should necessitate that support by consortium partners should gradually fade out, which should imply that stakeholders in an SLE should be able to take more initiative, they should be willing to assume ownership of the process, overall, and therefore, they should not need as much support as the SLE evolves as they could have needed in their initial steps. The above-mentioned difference between pilot and mature cycles will require that the toolkit already described in the previous section should be enriched with tools and heuristics based on the experiences gained by stakeholders, which will be deployed to support SLEs in the mature cycle (SLEs support mechanism). This enriched toolkit will be available online to all stakeholders through the website of the project. Again, SLEs' general characteristics and stakeholder input in the template of participatory scenario development will provide all required data.

## 6.1 Risk diagnostics

Risk diagnostics should include a set of indicators to identify risks for the SLEs support mechanism, which should provide a quick but comprehensive overview of gaps and inconsistencies within an SLE, in this regard. A frequent risk in terms of support is encountered when stakeholders adopt learning resources, they have not themselves developed. In cases of that kind, the familiarization and prior experience of stakeholders with such resources may not be enough to allow them to provide thorough and timely feedback and support to learners. But even if stakeholders dispose of learning resources they developed in-house, then the stakeholder members available to provide support and feedback to learners may not be adequately trained or prepared to do so. Because learner support in SLEs must be offered as soon as possible, and even on-the-fly in some cases, the gaps and inconsistencies highlighted above may compromise learning experiences and outcomes substantially. The pilot cycle of the project is expected to provide a set of indicators based on the concerns presented in this paragraph that can be employed to identify analogous risks for the SLEs' support mechanism.


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## 6.2 Valorization of strengths

A final question to be addressed is how can SLEs capitalize on their strengths so that they can create and diffuse as much added value as possible to stakeholders in the coalition and beyond. It can be often the case that stakeholders may not recognize or that they may downplay the strengths in their coalition, namely, characteristic features that are likely to propel constructive stakeholder interaction and processes that may have worked well. An objective in the pilot phase of the project will be to document such positive aspects and developments so that the stakeholder coalition can take advantage of them and so that SLEs in the mature phase can gain from previous experiences. In some instances, for example, experienced members of stakeholders may be able to transfer their knowledge and skills for fostering learner support to other stakeholder members in the same group or to other groups in the coalition, which may prove crucial for the development of an SLE and for successful learner engagement. Exchanges of this type are anyhow opportunities for initiating mentoring processes between stakeholders in an SLE with a pronounced empowering orientation.

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