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The development of an initial ECF

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WHO WE ARE

The ECF consortium consists of ten partners. The project is coordinated by Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas-CIEMAT.

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Smartwatt Energy Services SA Smartwatt	PT	
Que Technologies Kefalaiouchiki Etaireia QUE	GR	



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ABOUT THE PROJECT

Through a multidisciplinary, transdisciplinary and participatory process, ECF4CLIM develops, tests and validates a European Competence Framework (ECF) for transformational change, which will empower the educational community to take action against climate change and towards sustainable development.

Applying a novel hybrid participatory approach, rooted in participatory action research and citizen science, ECF4CLIM co-designs the ECF in selected schools and universities, by: 1) elaborating an initial ECF, supported by crowdsourcing of ideas and analysis of existing ECFs; 2) establishing the baseline of individual and collective competences, as well as environmental performance indicators; 3) implementing practical, replicable and context adapted technical, behavioural, and organisational interventions that foster the acquisition of competences; 4) evaluating the ability of the interventions to strengthen sustainability competences and environmental performance; and 5) validating the ECF.

The proposed ECF is unique in that it encompasses the interacting STEM (Science, Technology, Engineering, and Mathematics)-related, digital and social competences, and systematically explores individual, organisational and institutional factors that enable or constrain the desired change. The novel hybrid participatory approach provides the broad educational community with an ECF adaptable to a range of settings; new ways of collaboration between public, private and third-sector bodies; and innovative organisational models of engagement and action for sustainability (e.g. Sustainability Competence Teams and Committees). Separate Sustainability Competence Teams (SCTs) for students, teachers and administration and Committees (SCCs) meet periodically during the ECF4CLIM process to ensure the participatory process.

To encourage learning-by-doing, several novel tools will be co-designed with and made available to citizens, including a digital platform for crowdsourcing, IoT solutions for real-time monitoring of selected parameters, and a digital learning space. Participation of various SMEs in the consortium maximises the broad adoption and applicability of the ECF for the required transformational change towards sustainability.



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1. EXECUTIVE SUMMARY

The initial ECF aims to be a practical document that describes the essential individual and collective competences and enablers and constraints of promoting environmental performance of educational institutions. It draws from the results of the ECF4CLIM crowdsourcing results, document analysis, and literature review. It is based on and further develops the sustainability competences outlined in GreenComp - the European sustainability competence framework, developed by the Joint Research Center of the European Commission (Bianchi & al. 2022). This ECF is structured as a roadmap and aims to provide tools for different stakeholders to map and foster the enablers and overcome the constraints of sustainability in various educational contexts. The roadmap comprises four steps.

The first step aims at engaging people in promoting sustainability. It includes strengthening their understanding of sustainability and human dependence on wellbeing of ecosystems. It strives to foster a collective will-formation process that considers different stakeholders' needs, values, and perspectives.

The second step aims at deepening people's understanding of the complexity of sustainability. It strives to help the educational community to ask the pertinent sustainability questions and allow them to create effective strategies for promoting sustainability. Successful promotion of sustainability requires an understanding of the given organisational context and mapping the relevant actors and learning contents in different disciplines. Systemic understanding of the state of the environment and connections to global sustainability issues are also important. It is essential to acknowledge the impact that cultural backgrounds and different worldviews have on problem framing and possible solutions. It is important to ask what kind of knowledge we have, and how the knowledge base, interests, and principles vary among people and in different disciplines.

The third step concentrates on envisioning alternative futures, mapping possible paths towards sustainability and promoting adaptability for changes and action. Given the current challenges, such as climate change and biodiversity loss, what is the future likely to hold for us, and what kind of future do we want? Additionally, the focus should be on the changes and acts needed for realisation of preferable sustainable futures. It demands a lot of courage and adaptability to take action towards a more sustainable future, although we cannot be certain about the outcomes. The contradiction between the current, likely and preferable futures needs to be considered. It is also important to remember that emotions have an impact on our cognitive and psychological adaptability. Therefore, a collective, supportive atmosphere with an active approach to sustainability is essential to promote a sense of hope, active coping, and an awareness how future is in our hands. Transformation towards sustainability requires us to change

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our perspective, question our assumptions and beliefs, foster transdisciplinary thinking, and unleash our creative potential in order to create new solutions. How can we act and live together in a sustainable way that might not yet exist?

In the fourth step the values and principles, the systemic understanding of sustainability, and the envisioned sustainable futures will contribute to designing strategies for action. The core question to consider is: who are the people and communities promoting sustainability, how, and where? The available resources and structures where the change can happen, need to be considered. Promoting sustainability requires multiple resources: people, time and space, money for procurement, pedagogical models and materials, collaboration and networking, as well as cultivating and utilising individual and collective human potential. The focus of action can be on gaining better resources, fostering relationships, as well as influencing attitudes and ways of talking and acting.

The road to promoting sustainability is not simple. Many aspects, interconnected issues, questions, and related details need to be considered in promoting concrete sustainability action in different contexts. The central purpose of the roadmap is to facilitate a participatory process that results in clarified visions and a purposeful strategy on how to proceed in promoting sustainability in each context and how to evaluate it.

2. OBJECTIVES AND INTRODUCTION

The initial ECF is a working document that aims to offer to educational institutions and the educational community at large practical guidance and a working tool for participatory promotion of sustainability in different educational contexts. It is based on crowdsourcing results that have been related to the draft of European Sustainability Competence Framework, which has been developed by the Joint Research Center of the European Commission and published in the form of GreenComp (Bianchi & al. 2022). Additionally, the initial ECF draws from the literature and policy framework review and analysis of the other relevant competence frameworks (Task 3.2) and the theoretical frameworks of ECF4CLIM.

The initial ECF seeks to provide tools for addressing internal and external obstacles that various stakeholders face in building sustainability competences. For this purpose, the initial ECF has been designed to serve as a roadmap that aims to facilitate a participatory process for developing sustainability in various educational contexts. The roadmap covers the aspects of individual and collective competences and environmental performance that have been regarded essential for the promotion of sustainability and climate mitigation actions in education and that are the core dimensions of the ECF4CLIM project. Although the structure and contents of GreenComp are used as a framework, all the content, details and issues focused emerged from the crowdsourcing practices and discussions among the participants.

Through the roadmap, we aim to highlight and illustrate why the specific competences are relevant and how they are needed in a participatory process of promoting sustainability education. The detailed definitions of knowledge, skills and attitudes with regard to sustainability are not included in this document as they are already described in GreenComp. The focus of this document is to facilitate participatory processes of promoting sustainability in education in various contexts of education in various organizations with diverse groups of participants. The roadmap helps to identify essential issues and relevant steps and actions to advance in sustainability in different contexts. The results of the ECF4CLIM crowdsourcing process (Deliverable 3.1) and review of literature and document analyses (Deliverable 3.2) have been used in the process of creating the concrete roadmap and making alive the competences that it focuses on. Each step of the roadmap comprises a) connections to GreenComp, b) aims of the step, c) contents, d) constraints and enablers, , and e)tools. Different societal and educational contexts have also been acknowledged in the roadmap.

The initial ECF will be co-tested and further co-developed in practice according to this roadmap at and with the demonstration sites during the rest of the ECF4CLIM project.

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At the end of the project, a final version of ECF will be elaborated to assist the promotion of sustainability in various educational settings in different European countries.

The report is structured as follows. After the introduction, Chapter 3 introduces the concepts and theoretical frameworks that form the basis of the initial ECF. Chapter 4 explains how the initial ECF was created, which perspectives and documents were used for selecting the essential aspects for the design of the roadmap. Chapter 5 presents a roadmap based on the initial ECF; the steps of the roadmap are directly based on competence areas that have first been introduced in the GreenComp. The roadmap furthermore follows the basic structure introduced in the ECF4CLIM project of individual and collective competences and environmental performance. Finally, the report ends with concluding remarks. The key methods, concepts, and data applied in constructing the roadmap are presented in Figure 1.



Figure 1. ECF4CLIM-roadmap as an operationalised framework for European Competence Framework for a Low Carbon Economy and Sustainability through Education.

3. METHODOLOGY

The initial ECF is a result of in-depth reflection. It builds on the results of crowdsourcing (Task 3.1) as well as literature review and document analysis (Task 3.2), relating them with GreenComp, other competence frameworks and theories. In this paper, the initial ECF is operationalised as a roadmap.

The crowdsourcing phase of the study, carried out in the spring of 2022 (Task 3.1), constitutes a crucial basis for our roadmap. The aim of the crowdsourcing process was to engender a collective meaning-making process, in terms of education for sustainability. A large, international group of students, parents, teachers, principals and experts in education were engaged in discussions on how to develop sustainability education. The crowdsourcing process was implemented through two different but mutually supportive crowdsourcing methods. First, a set of “Dream and nightmare school” -workshops were organized to stimulate discussions on the participants’ experiences on the enablers and constraints of sustainability education. These workshops gathered about 500 participants altogether in 31 workshops. Second, online discussions for international audiences were facilitated on the eDelphi platform to obtain a deeper understanding of the issues addressed in the crowdsourcing workshops (68 active participants). The data generated through crowdsourcing thus includes post-it notes from participants, facilitators’ notes, and the national and international stakeholder discussions on the eDelphi platform. The findings derived from both inductive and deductive qualitative analysis are processed in the roadmap. The detailed explanation of methods applied, and main results are described in the deliverable 3.1¹.

Literature review and document analysis conducted in spring 2022 (Task 3.2) brought the background information and policy documents to the stage. D3.2² reports the results of the literature review and the comparative analysis of sustainability competences based on relevant national and international policy documents. It was especially useful for considering collective competences.

The process with this initial ECF and roadmap began with comparing the results from the tasks 3.1 (crowdsourcing) and 3.2 (document analysis) with the GreenComp. The crowdsourcing results were compared with the results of the document analyses in order to identify different countries and stakeholders’ perspectives. Besides, the crowdsourcing participants’ ideas of the tools and essential next steps for developing sustainability in education were detected and integrated in the roadmap. The development of the baseline assessments of environmental performance, as well as

¹ https://www.ecf4clim.net/files/ugd/1088b3_864871321c3a47eda4b1f050cbf0b79e.pdf

² https://www.ecf4clim.net/files/ugd/1088b3_de3c1864c5af4171b3aff12b56deb3cb.pdf



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individual and collective competences in WP4 were also considered in the roadmap design.

The roadmap includes a large variety of possible perspectives how to operationalise sustainability competences. It. The value of the perspectives depends on the context and the stage of sustainability in the school or educational organisation in question. New perspectives may also emerge during the whole ECF4CLIM research process. Especially the iterative and reflective work with Sustainability Competence Teams and Committees (SCTs & SCCs) will provide the basis for an on-going participatory evaluation of the initial ECF.

4. BACKGROUND: CONCEPTS AND THEORETICAL FRAMEWORKS

In this section, the main concepts and frameworks that were applied while creating the roadmap are defined and explained.

Sustainability and sustainability competences

Based on UNESCO's statements, sustainability is described in GreenComp as a long-term goal of attaining a more sustainable world. It requires taking into account the needs of all life forms on the planet by ensuring that human activity does not exceed its planetary boundaries. According to GreenComp (Bianchi, Pisiotis & Cabrera 2022, 12) "sustainability competences empower learners to 1) embody sustainability values, and 2) embrace complex systems, in order to 3) take or request action that restores and maintains ecosystem health and enhances justice, generating 4) visions for sustainable futures".

GreenComp

The European Sustainability Competence Framework, *GreenComp* (Bianchi & al. 2022), identifies a set of sustainability competences designed to feed into education programmes to help learners develop knowledge, skills and attitudes that promote ways to think, plan and act with empathy, responsibility, and care for our planet and for public health. It comprises four interrelated competence areas, each further divided into three interlinked and equally important competences (Table 1).

This initial ECF GreenComp was used as a working document, which we subsequently operationalized based on the results from crowdsourcing that were transformed into a roadmap. The roadmap aims to build individual and collective competences for sustainability education and promoting sustainability as environmental performance.

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Table 1. Competence areas and competences in the European sustainability framework GreenComp

Competence areas	Competences
Embodying sustainability values	Valuing sustainability Supporting fairness Promoting nature
Embracing complexity in sustainability	Systems thinking Critical thinking Problem framing
Envisioning sustainable futures	Futures literacy Adaptability Exploratory thinking
Acting for sustainability	Political agency Collective action Individual initiative

Individual competences

In general, the concept of competence means the ability to do something well (Oxford English Dictionary 2022), or the ability to meet or surpass the prevailing standards for adequacy for a particular activity (Butler 1978). Based on these definitions, we elaborate the definition of sustainability competences *as an ability to act in an appropriate way to achieve sustainability goals successfully and efficiently*. This general definition applies both individual and social competences.

Individual competences refer to the “development of a combination of personal qualities and (possibly) qualifications” (Vare 2022), knowledge, skills and attitudes that are needed to achieve certain goals through his/her actions and activities, in this case to promote a more sustainable way of life. In the roadmap, individual competences constitute one of the three main aspects and refers to the individuals’ inner, personal qualities and abilities. ECF4CLIM aims to assess the individual competences of students, teachers and administrative staff and changes in the competences through base-line evaluation and post intervention evidence. In the roadmap the descriptions of the individuals needed in each step refer to competences of students, teachers, administration, and other educational stakeholders. It is not possible to define who needs those specific competences as it depends on the context and the level of education.

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Collective competences

Collective competences refer to the organisations' ability to take action on a given issue as a community, in a collective way, or an innate quality of an organism or system (e.g. Vare 2022). These competences have different dimensions: on the one hand, they may refer to an obligation or freedom – duty or right – given for the organisation by an external authority, like the state, to act upon a given issue. On the other hand, they may refer to the organisation's internal capacity to determine what action it wants to take and how. In the ECF4CLIM project, the working definition of collective competences draws from Scott's (2013, 60) work on institutions, and thus categorises collective competences as regulative, normative, or cultural-cognitive competences. Integrated in the roadmap process, ECF4CLIM aims to identify and foster collective competences for educational institutions, such as national school curricula that condition the ways in which sustainability is integrated into teaching in the different disciplines (regulative competences); and the internal strategic and operationalised approach to act sustainably at the organisational level (normative competences). The collective competences may include also pedagogical skills, training, adequate facilities, and actual teaching and collective learning. Collective competences are also manifested in the operating culture and collective atmosphere, including social norms and attitudes (cultural-cognitive competences).

In the roadmap, collective competences refer to the organisations' ability to take action on a given issue as a community, in a collective way. In ECF4CLIM collective competences will be assessed through (baseline / and post intervention evidence).

Environmental performance

Environmental performance refers to the verifiable performance of a society to manage its impact on the environment. Measuring and reflecting on environmental performance are integral elements in the process of roadmap elaboration. To operationalize the evaluation of the environmental performance, the ECF4CLIM project has chosen a limited number of environmental performance indicators relating to resource, energy, and water consumption, emissions, indoor air quality, transport, green procurement, green spaces, indoor air quality, and waste management. Various environmental impacts and energy efficiency of the buildings at the selected demonstration sites are assessed, to estimate their environmental performance. The change in environmental performance is assessed during the ECF4CLIM project through pre-audits and post-audits. That is, before and after the interventions designed to improve the environmental performance of these school premises. In the roadmap, environmental performance refers to the concrete environmental impact of the educational organization's buildings, premises and behaviour.

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Methodological frameworks

One of the most central questions of ECF4CLIM project is to understand what impedes and what enables educational practices to become more sustainable. Understanding this is essential in order to remove potential barriers to green transitions of the European societies. To this effect, we apply the *theory of practice architectures* (Kemmis 2022), which specifically pays attention to the preceding factors, or ‘practice arrangements’ that prefigure (enable and/or constrain) our practices. These practice architectures consist of (1) cultural-discursive, (2) material-economic, and (3) social-political arrangements. These arrangements prefigure, but not predetermine the particular practices on a given site, manifested through (1) discourses (‘sayings’), (2) physical activities and actions (‘doings’), as well as (3) power relations (‘relatings’), including solidarity and loyalty (Kemmis 2022). These different dimensions are intertwined in our everyday practices. This understanding of social practices forms a natural continuum with the methodologies of participatory action research (Kemmis et al. 2015), while the theory of practice architectures aims to identify the arrangements that prevent us from changing practices.

The practice architectures can be compared to a network of paths that makes it possible to walk in the forest. The path does not predetermine where you can go; you can also progress elsewhere than along the paths. However, the network of paths makes it easier to move on the terrain. Thus, it enables, but also limits the range of possible routes. Anyway, you always have free will to choose which route to take. Unlike the causal laws of nature, practice architectures do not determine practice, but they provide a set of opportunities for human agency.

5. ROADMAP FOR PROMOTING SUSTAINABILITY COMPETENCES IN EDUCATION

This chapter introduces the concrete steps of the roadmap related to GreenComp competence areas. The aspects of individual and collective competences and environmental performance, which are the core dimensions of ECF4CLIM, have also been included in the steps of the roadmap. The design and the content of roadmap is based on the results of crowdsourcing (Task 3.1), especially in the typical constraints, enablers, and tools for each step.

Each step provides essential aspects, reflective questions, enablers, and tools for encountering the constraints of promoting sustainability in education. The GreenComp provides the detailed definitions of specific knowledge, skills, and attitudes that are essential in the different phases of the roadmap.

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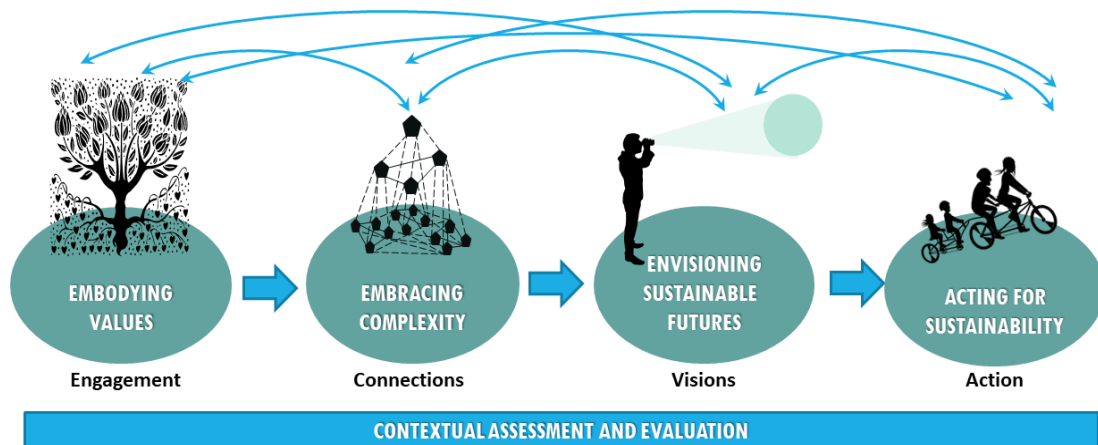


Figure 2. Competence areas in GreenComp and ECF4CLIM-roadmap

The roadmap consists of four steps.

- The first step invites and engages people through reflection and inclusive dialogue on the values and meanings of sustainability. It aims to foster the emergence of a common understanding of sustainability and common good. It also establishes the principles for promoting fairness in collaboration.
- The second step aims to find systemic connections between everyday life at school or another educational organisation, to promote critical thinking about learning contents, different disciplines, the state of the environment, and the perspectives of other involved actors.
- The third step focuses on envisioning futures, adaptability, mapping possibilities for change and visions of a desirable future.
- The fourth step aims at concrete action and evaluating the results. It is important to bear in mind that although each step emphasises a specific competence area of GreenComp, all four competence areas are intertwined at every step.

The description of each step of the roadmap follows the same structure. First, narrative introductions and definitions of the competences of the competence area in GreenComp are provided. Second, the aims of the step are described. Third, the essential contents of the step are presented, drawing on the findings from the crowdsourcing exercise and document analysis. The content is structured under the headings “individual competences”, “collective competences” and “environmental performance”, even though these three levels are intertwined in everyday life. By individual competences we refer generally to competences of both students, teachers, administration and other educational stakeholders as relevant competences are contextual and depend on the level of education. Fourth, an example of the development process of each step is presented. Fifth, possible constraints and enablers associated with the step are described. Last, some tools and materials related to the steps in question are provided.



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There is no single “correct” way of using this roadmap. Each educator or community has different current needs. Also, the contexts such as operational culture, societal circumstances, and resources vary. These all should be considered when framing the focus of any given planned activity and project. In the final version of the ECF at the end of the ECF4CLIM process we may provide facilitating tips for the use of the roadmap based on the evidence gathered at the different demonstration sites.

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Step 1 ENGAGEMENT: Why and how to promote sustainability?

Working at a school or other educational institution necessitates balancing between multiple and sometime mutually contradictory values and objectives. Therefore, it is difficult to operationalize values and ideals into pedagogical practice, and we end up with making compromises continuously. Successful promotion of sustainability demands prioritization and collaboration, thus the core question is how to enhance the understanding and reflection on the meanings of sustainability and engage the community in promoting sustainability together. This requires organizing time and space for collective reflection on values and on ways to agree on common goals despite the existence of varying value hierarchies. Acting according to individual and collectively shared values is important also for wellbeing and work satisfaction. This step on our map derives from the GreenComp competence area “Embodying sustainability values”.

GreenComp: Embodying sustainability values

Valuing sustainability

To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.

Supporting fairness

To support equity and justice for current and future generations and learn from previous generations for sustainability.

Promoting nature

To acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems.

Aims

This step aims at promoting collective understanding of the meaning of sustainability and engaging wide audiences by facilitating inclusive dialogue on sustainability. Moreover, the aim is to foreground fairness and critical awareness of how we can promote sustainability and protect nature through our practices. This phase of engaging and involving people is essential for strengthening their motivation to participate and work together for sustainability. In addition, this step enables the mapping of the individual and collective value basis. Considering different stakeholders’ varying needs and value hierarchies is essential for motivating and engaging people in the collaborative process of creating the roadmap for transformations towards sustainability.

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Contents

This step includes the elements³ of (a) Engagement through a participatory process; (b) Sustainability knowledge and fairness as common grounds for discussion, and (c) Inclusive value reflection and dialogue.

Engagement through a participatory approach

How to motivate and engage wider audiences in promoting sustainability as individuals and as communities is the essential issue in education and in general advocacy of transformations to sustainability.

At the level of individual competences, being able to argue for and take initiatives for the collective promotion of sustainability is essential. Individuals need knowledge about the varying motivators, meanings and values related to sustainability and skills of promoting engagement. Besides, even those participants that may not be very interested and experienced in sustainability education need to experience that their experiences and opinions are regarded as relevant. Criticism and resistance are considered valuable for the collective development process.

At the level of collective competences, it is essential to allocate resources to have time and place for designing the participatory process for creating the roadmap. Thus, organisational management has a crucial role in allocating resources for the collective process. It is important to map what kind of principles, processes and practices exist already and identify those that need to be established for the roadmap process. This mapping continues in the step 2. Involving and engaging different types of people with different perspectives and skills and considering them as valuable in the collective development process is also a collective competence.

For environmental performance, a crucial question in engaging people for acting for sustainability is whether education can make a change in environmental behaviour. Measuring concrete environmental impacts from those measures that are designed to enhance sustainability can be an essential aspect for motivating people to act. Assessing how educational interventions change the environmental impact of a school or another educational establishment is a central dimension of ECF4CLIM. However, it is essential to acknowledge that the indirect yet vital impact of education on environmental performance, via changes in attitudes and behaviour for example, is hard to measure.

³ These have arisen from crowdsourcing, document analysis of ECF4CLIM-project and GreenComp.

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Sustainability knowledge as a common ground for discussion

To establish the common ground for value reflection it is good to introduce some facts about sustainability, planetary boundaries, and how we are dependent on nature⁴. This may help to direct the focus on the ecological foundations of life and help people to understand all the interconnecting dimensions of sustainability. The core task is to emphasize the vital understanding of the interrelatedness of human wellbeing with the wellbeing of the whole biosphere.

As for individual competences, it is essential that people have at least a minimum basic knowledge on sustainability. To argue for the importance and relevance of promoting sustainability it is essential to acknowledge the various aspects that GreenComp provide. Supporting fairness entails promoting equity and justice within the present generation, between present and future generations, and between humans and other species. This emphasizes the necessity to promote sustainability for the sake of our common future as a biosphere and the need to learn from past traditions and actions. Promoting nature is about fostering caring attitudes to other species and planet and developing empathy towards them. It also requires systemic knowledge about natural environments⁵.

It is essential to also improve the understanding, among the various involved actors such as students, teachers, administrative staff, and the wider educational community, of the normative nature of sustainability science – in contrast with many other disciplines that produce mainly descriptive knowledge. Sustainability science helps us to understand how the world should look like, given the dependence of the human and societal systems on healthy ecosystems. Most other sciences produce knowledge about how things are, rather than on how they should be.

Individuals' skills of dialogue are essential for sustainability. To facilitate dialogue and successful participatory processes, it is important to acknowledge that advancing sustainability can serve several goals and values: social, cultural and economic dimensions of sustainability are related to ecological sustainability. Hence, this step is in

⁴ GreenComp defines Sustainability as means prioritising the needs of all life forms and of the planet by ensuring that human activity does not exceed planetary boundaries. Planetary boundaries describe how human activities, based on fossil fuel use, cause or accelerate detrimental changes to the planet (GreenComp p. 14). Scientists have identified nine Earth system processes that need to be monitored and not crossed, such as (Figure 2): i) biosphere integrity, ii) land-use change, iii) climate change, iv) freshwater use, v) ocean acidification, vi) biogeochemical flows (nitrogen and phosphorus cycles), vii) atmospheric aerosol pollution, viii) stratospheric ozone depletion, and ix) release of novel chemicals.

⁵ In GreenComp the state the relevant knowledge covers the main parts of the natural environment (geosphere, biosphere, hydrosphere, cryosphere, and atmosphere) and the close links and interdependence between living organisms and non-living components.

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close relation to the systems understanding of interconnectedness, critical thinking, and the impact of various cultural backgrounds on efforts at advancing sustainability.

For collective competences, curriculum and multidisciplinary learning modules that include sustainability and connections to ecology are important. Every discipline and subject have its unique perspective to environmental sustainability. It is good to discuss collectively about this connection in order to reach a common understanding. Additionally, collective discussions on the normative nature of sustainability science compared to other disciplines are needed.

As for environmental performance, a task essential for sustainability is to reflect on whether our personal and collective values, ways of thinking, plans, and actions cause harmful impacts and to what extent they are in line with sustainability values. This is closely related to the second step of the roadmap.

Inclusive value reflection and dialogue

The principles of multivocal and deliberative discussions not aiming at consensus but pluralism, are essential in engaging people with multiple cultural backgrounds with versatile value perspectives and hierarchies. Engaging and involving people in inclusive discussions on the varying perspectives and meanings of sustainability and by clarifying the collective value basis is essential for people's motivation to participate and work together. Considering different stakeholders' varying needs and value hierarchies also helps in collectively defining the concrete changes needed in the organization to foster transformations towards sustainability. It is essential to acknowledge that advancing sustainability can serve several goals and values and how the different dimensions of sustainability social: ecological, economic, cultural and social are interconnected. Thus, this step is in close relation to the systems understanding of interconnectedness in Step 2.

As for individual competences, it is essential to facilitate personal value reflection on what kind of aspects of sustainability are important, and what kind of values are relevant individually. Values are realised in priorisations when choosing between different options. Educators need to have pedagogical competence for facilitating inclusive sustainable value reflection processes with their students.

For collective competences, recognizing the values of the community and society helps in the work towards sustainability. Collectively shared values are materialized in regulations, documents, norms, modes of action, dialogue, and communication. It could be useful to analyse what kind of values such documents reflect, how the values from the documents are reflected in everyday practices, and whether we are promoting sustainability and nature through our activities. It is essential to prioritize value discussions and arrange time, space, and other resources for them. Besides, the principles of respectful and inclusive discussion need to be defined and reflected upon together.

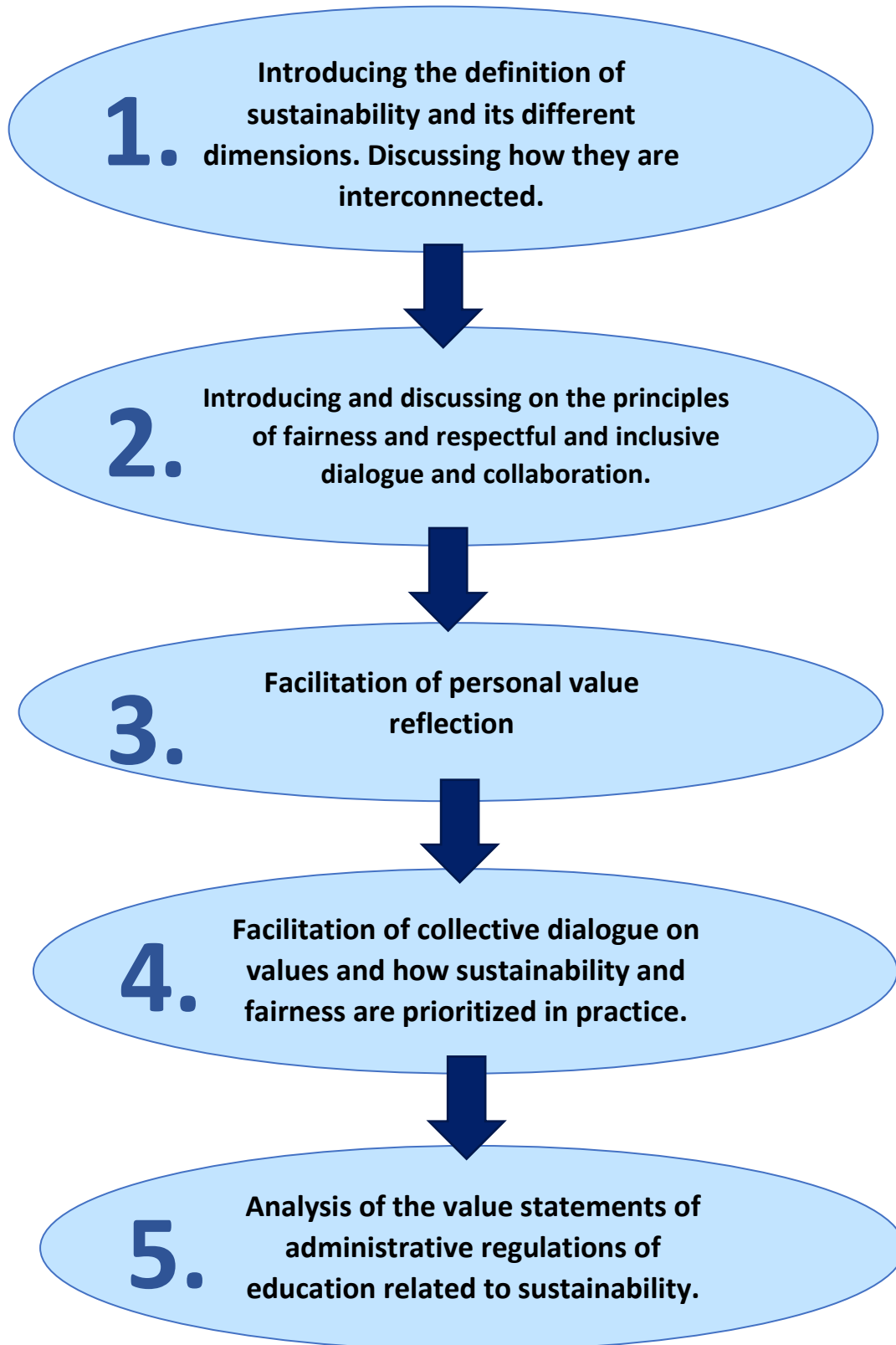


D3.3, The development of an initial ECF

As for environmental performance, our values also have repercussions on the environmental impacts of the educational organisation that we are part of. Material practices in our everyday lives often reveal our true values. Attitudes to nature and sustainability reflect in material choices, in ways that people treat the environment, or ways of housekeeping. Cooperation in advocating for sustainability between different professions is crucial.

D3.3, The development of an initial ECF

An example of a process of facilitating collective value reflection



D3.3, The development of an initial ECF

Constraints and enablers concerning ENGAGEMENT

This step on the roadmap could reveal contradiction between values and the current objectives of education (cf. Engeström 1987; Engeström & Sannino 2010), which reveal the need to change. Management plays an essential role in promoting inclusive and meaningful dialogue on values. Hierarchical organization, lack of collective value clarification and dogmatic teaching constrain successful advocacy for sustainability in education. Therefore, participatory approaches have been regarded as the key in promoting sustainability competences. Only appealing to individual responsibility and administrative regulations and procurements for sustainability are not alone enough to engender desired change. The possible enablers and constraints of engagement are summarized in the following figure.

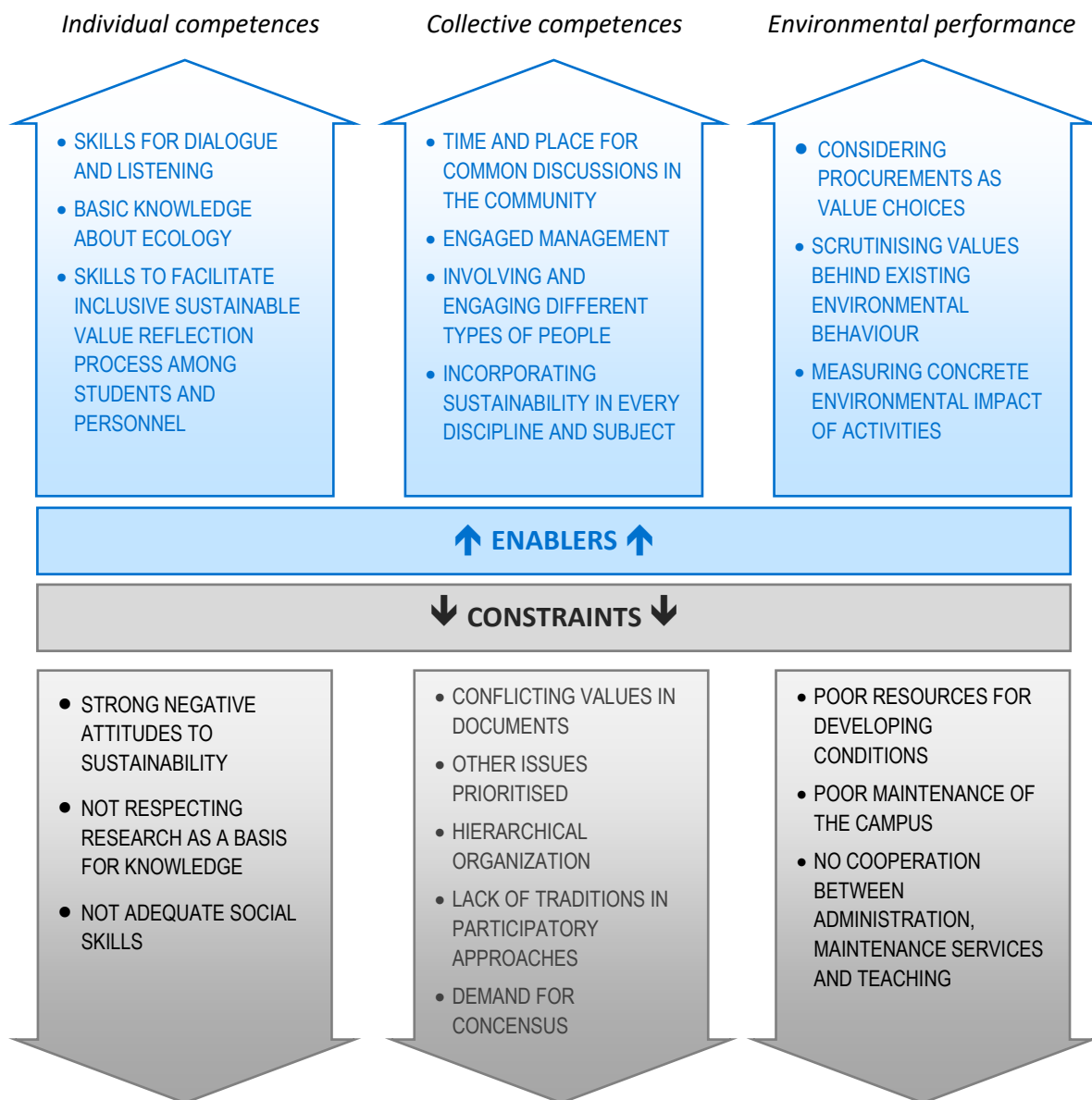


Figure 3. In the field of engagement, what could enable or hinder work towards sustainability

D3.3, The development of an initial ECF

Tools for Step 1

Here are some tools which you can use when taking the step 1. During ECF4CLIM-project⁶, more tools are collected and tested by partners and demonstration sites.

Tools provided in ECF4CLIM-project for the step “Engagement”

- Development of an ECF for climate change and sustainable development (WP3)
 - Participatory will formation: crowdsourcing methods “Dream school workshops” and eDelphi discussion (Task 3.1)
 - Analysis of literature and existing policy frameworks (Task 3.2)
- Baseline assessments (WP 4)
 - Document analyses for collective competences (Task 4.1)
 - Assessment questionnaire for individual competences (Short questionnaire) (Task 4.2)
 - Analysis on the results of the assessment of individual and collective competences and environmental audits (Task 4.1-4.3)
 - Facilitating the work of Sustainability Competence Teams (SCT) and Sustainability Competence Committees (SCC) with co-design of measures to promote competences, behaviours and social practices towards climate action and sustainable development (Task 4.4)

Questions for pedagogical reflection and development

- How to learn to acknowledge that humans are part of nature; and to respect the needs and rights of other species and nature to restore and regenerate healthy and resilient ecosystems?
- How to foster empathy and care towards the planet and other species?
- How to promote ability to critically analyse the sources and types of knowledge.
- How to take into consideration the different cultural backgrounds, also of minority and indigenous groups?
- Do our pedagogical practices promote fairness: How to set sustainable principles of collaboration?

⁶ The ECF4CLIM process is described in the beginning of the report in the section About the project. More detailed description can be found in The ECF4CLIM process is described in the beginning of the report in the section About the project. More detailed description can be found in <https://www.ecf4clim.net/>. The project management plan: https://www.ecf4clim.net/files/ugd/1088b3_3a891432c1844fca8fb546b0a1056a04.pdf

D3.3, The development of an initial ECF

Personal reflection:

- What do I value?
- What kind of aspects of sustainability are important to me?
- Which dimensions and aspects of sustainability are relevant for my field?
- What do I prioritize in my life?

Collective reflection & inclusive dialogue:

- What do others and my community value?
- What is common to us?
- What kind of values do our organization and society have and how are they defined in official documents and regulations?
- How do our values reflect and are realized in practices?
- Are we promoting sustainability and nature through our practices?
- How to promote inclusive discussion and common-good thinking around sustainability and engage people with different value systems?
- How can we promote fairness while advocating sustainability?
- How to design and apply participatory and inclusive approaches while making our roadmap?
- What kind of principles, processes and practices do we already have and what needs to be established together for the roadmap process?

Reflection on environmental performance:

- Of which KPIs (Key Performance Indicators) does environmental performance consist of?
- How do we and our organization influence ecosystems?
- What do we prioritize in practice?
- Do we act according to our values?
- What do we prioritize related to our environmental practices and performance?
- How could we enhance value-driven actions?

Exercises, methods, models, and materials

- Methods for inclusive dialogue: e.g. *Time out* -method for constructive dialogue² by Sitra (Finnish Innovation Fund).

² <https://www.sitra.fi/en/timeout/>

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- Conceptual tool: Planetary wellbeing⁸ for understanding how human wellbeing depends on ecosystems wellbeing
- Assess and compare the environmental performance in relation to our values: Do we act according to our values?
- Launch a campaign for sustainable action! Study basics of visual media and design (for example: <https://www.marq.com/blog/6-essential-elements-graphic-design-poster>), make posters, plan a flash mob (for example: <https://wonderopolis.org/wonder/what-is-a-flash-mob>) or create performance art (for example: <https://www.tate.org.uk/kids/explore/kids-view/meet-performance-artist>) to get powerful results
- The FEE (Foundation for Environmental Education) makes a call for all the participants in the educational programs and open to anyone, to engage in the Global Action Days in April, to demonstrate how our individual actions, both small and large, can have a significant impact on the wellbeing of ourselves, our communities, and our planet. During those days, a variety of activities take place in local community and are posted in social media with the hashtag: #GlobalActionDays to spread the message and share ideas among participants. Resources for the campaign may be found in: <https://www.fee.global/gad-resources>
- Spanish material: Measuring wellness. Understand the relevance of ecosystem services for life. https://www.naturalizaeducacion.org/sesion_doble/midiendo-el-bienestar/
- Romanian material: <https://creeracord.com/2016/11/15/sustenabilitatea-o-noua-competenta-transversala-si-obiectiv-transformational-al-educatiei-actuale/>
- Romanian material: <https://www.presidency.ro/files/userfiles/Raport%20Educatie%20Clima%20si%20Mediu%20iunie%202022.pdf>
- Finnish materials see: MAPPA.fi -service

⁸ Article: <https://www.nature.com/articles/s41599-021-00899-3>; Course on Planetary wellbeing: https://www.avoin.jyu.fi/en/courses-offered/planetary_wellbeing

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Step 2. CONNECTIONS: How to frame the problem?

At schools and other educational institutions everyday life flows through separate situations. The wholistic nature of the issues is hard to grasp. Without recognising connections and underlying assumptions, it is impossible to find the root causes and frame the problems in a satisfactory manner. To collectively define the problem, it is also relevant to understand the different perspectives to sustainability, and how our context and cultural background shapes the ways in which we see the problems and our knowledge about these issues. This step on our map derives from GreenComp competence area “Embracing complexity in sustainability”.

Embracing complexity in sustainability in GreenComp

Systems thinking

To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.

Critical thinking

To assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds influence thinking and conclusions.

Problem framing

To formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify suitable approaches to anticipating and preventing problems, and to mitigating and adapting to already existing problems.

Aims

The aim of this step is to identify and examine the connections that link the everyday life of the school or other educational organisation in question with other actors, learning contents, different disciplines, and the state of the environment. This helps to trace the root causes – systemic, structural, human and cultural issues – behind unsustainable activity and culture. With this knowledge it is possible to frame the problems and the scope: where we want to focus and have impact. At the same time, we acquire competences (knowledge, skills, and attitudes) that help us to better understand the complexity of sustainability problems and assess the available information.

D3.3, The development of an initial ECF

Contents

In this step of connections, at least the following three issues are central for making education more sustainable: (a) Complexity and root causes of environmental impact; (b) Underlying assumptions; and (c) Current state of practice.

Complexity and root causes of environmental impact

Schools and other educational organisations are not disconnected from the rest of the world. It is not simple just to decide and change the individual or collective activities to more sustainable ones: our relationships with other stakeholders, factors and systems can drive us towards unsustainable actions and constrain our ability to promote sustainability.

For individual competences, it is important to acquire a systems understanding how environmental challenges are interconnected and interlinked with economic activities, culture and both environmental and educational policies on various governance levels, from local to global. Understanding sustainability demands understanding connections between different disciplines. Lifecycle thinking can help to identify the root causes of environmental impact on personal, community and cultural level. This relates to the knowledge about ecosystems and biosphere described earlier in the first step (Engagement). It is essential to figure out how to deepen general understandings of these issues.

As for the collective competences, it is important to learn/investigate what kind of local issues and stakeholders are related to and involved in local sustainability activities. It is essential to develop methods that allow the identification of all key actors. This creates systems understanding of the organisation. Critically mapping out the systemic, regulative, and normative constraints in local context help to trace the societal and organisational roots of unsustainable activities. From a strategic perspective, it is beneficial to identify enablers and opportunities that have the greatest potential to trigger change for sustainability.

With regard to environmental performance, it is important to map relevant local actors related to consumption at the school: where the electricity comes from, where wastewater goes, are there options of change in this (different electricity producers), what kind of public transport is available, are there accessible green spaces, who are in charge of purchasing decisions concerning green spaces, electric contracts, water faucets, or other procurements, and where the resources to procurements come from.

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Underlying assumptions

Immediate sources of environmental impacts can be rather easily traced. However, some root causes are less readily observable, such as personal and collective assumptions, attitudes and cultural conventions that may constrain or enable sustainability.

At the level of individual competences, critical assessment of personal thinking can reveal false assumptions that are not backed up by evidence. What are the reasons that make me think and act as I do? The personal history and experiences or social networks have impact on my opinions and actions and on things that I do or not do.

Knowledge can change attitudes and assumptions, but official “cold” knowledge and information might feel like distant and meaningless, while “warm” knowledge that we gain from personal social networks and through participatory approaches can be very influential⁹. Individual agency emerges from cultural lifestyles, social contexts, and underlying power relations. It is essential to find methods for developing competence for critical reflection on personal cognitive patterns and mapping individual worldviews that is connected to the value reflection in Step 1. of this roadmap.

At the level of collective competences, tacit knowledge and cultural habits create norms and rules that are not said out loud. Critical understanding of our cultural values and norms helps us to understand the impact that culture has on our ways of responding to sustainability issues. Traditionally, arts have had a relevant role in questioning and provoking critical awareness of cultural assumptions.

At the level of environmental performance, the underlying assumptions can drive us to make wrong choices. False assumptions can concern the environmental impact of behaviours or the quality of sustainable choices (for example, that vegan food cannot be tasty). Personal experience can change the assumptions.

Current state of practice

To move forward in sustainability at a school or another educational organisation, one key phase of the roadmap is to map the current state of practices. From the perspective of the environmental impact, there are both negative practices, activities that generate e.g. CO₂ emissions (footprint), and positive activities, like teaching and learning about sustainability (handprint). The mapping of both footprints and handprints helps to identify the most acute sustainability issues in the context in question and frame the problem.

⁹ Ball, S.J., and C. Vincent. 1998. I heard it on the grapevine: ‘Hot’ knowledge and school choice. *British Journal of Sociology of Education* 19, no. 3: 377–400; K. Slack, J. Mangan, A. Hughes & P. Davies (2014) ‘Hot’, ‘cold’ and ‘warm’ information and higher education decision-making, *British Journal of Sociology of Education*, 35:2, 204-223, DOI: 10.1080/01425692.2012.741803

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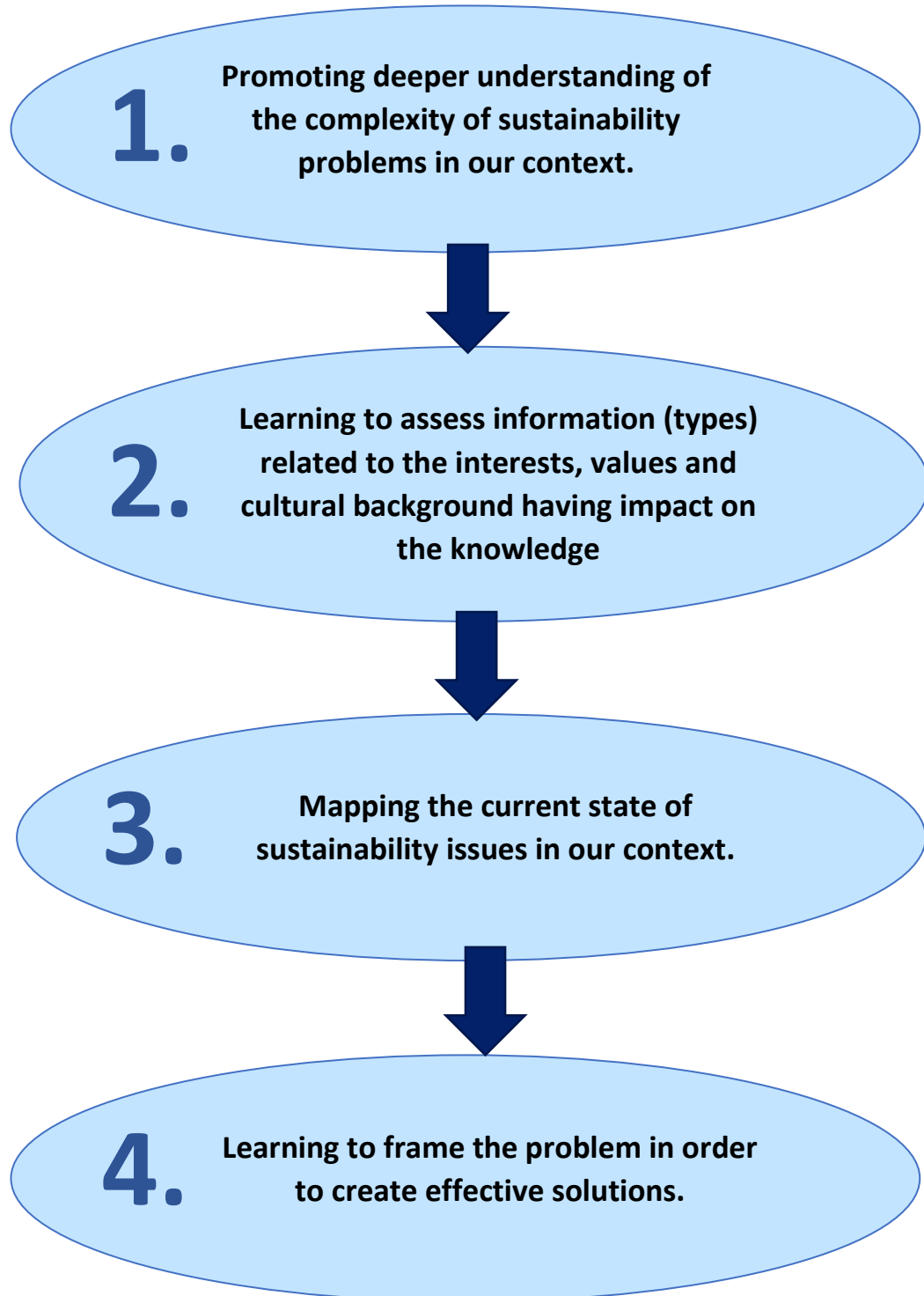
At the level of individual competences, understanding how individual behaviour is related to wicked environmental problems can be achieved by mapping individual, contextual unsustainable behaviours. The skills of recognising different kinds of sustainability problems in everyday life are essential: how the problems are intertwined and how they link to personal choices. Knowledge about possible solutions and impact of possible changes on systemic level help to frame the most accurate problem from the behavioural point of view. In ECF4CLIM this happens through co-design of measures for the interventions

At the level of collective competences, critical analysis of the current state of practice helps to frame problems on organisational level in educational organisation. Educational organisation should be seen as an environmental, social, cultural, and economic system. Regulations by e.g., national or local administration can foster sustainability by demanding educational organisations to measure their impact on carbon dioxide emissions. National educational administration can also have national assessments regarding sustainability education. Educational organisations can also have their own norms on how to measure current state of sustainability issues. An educational organization can for example take part in an EcoSchools program with regular assessments, or they can take part in other certification system. Additionally, a local sustainability team may regularly conduct its own measurements. From a cultural-cognitive perspective, change in the culture of an organisation is always a challenge. It is also relevant how environmental performance is measured and advocated for the collective benefit, to develop the organization: If these measures noted and valued among teachers and students or if they are seen only as something that one does to satisfy a formal requirement. In the latter case, measurements cannot be effective approach in fostering educational change towards sustainability.

At the level of environmental performance, it is important to find relevant measures that focus on the problems that are the most acute in the given context. Using scarce resources for something that is not a priority in one's own context is not helpful. Hence problem framing is a crucial task. Sometimes preliminary measurements are needed to frame the problem, prior to the final choices of the measures to be undertaken. For example, such early measurements can be needed to determine which activity produces most carbon dioxide emissions or creates the most valuable handprint. Technology might help, but it is not always the best solution. Easy solutions may not always trigger the desired change.

D3.3, The development of an initial ECF

An example of a process: how to promote understanding of connections and frame the problem



D3.3, The development of an initial ECF

Constraints and enablers concerning CONNECTIONS

This step on the roadmap could reveal contradiction between the current ways of organising things and turning into practice the values (cf. Engeström 1987; Engeström & Sannino 2010) discussed in the previous chapter (Step 1). Needed tools, rules, and structures could be missing in the organization. There can be also difficulties in sharing of responsibility or with power relationships. These constraints can be very frustrating and slow down the progress. At the same time, without confronting these difficulties there is no way of getting forward.

As a summary of the step 2, there are some factors related to connections that could hinder or enable work towards sustainability in educational organisations that are summarized in the following figure.

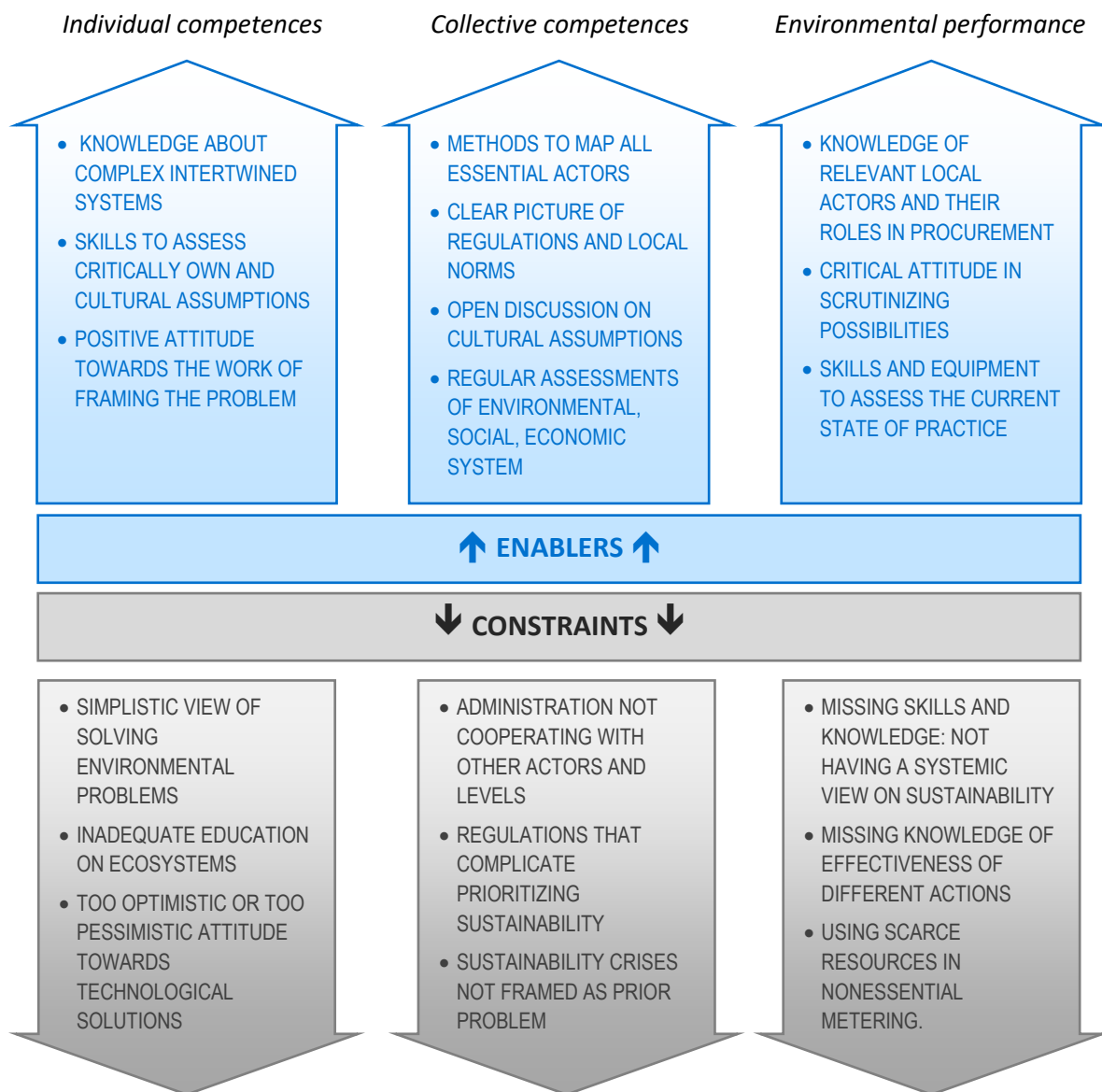


Figure 4. In the field of connections, what could enable or hinder work towards sustainability

D3.3, The development of an initial ECF

Tools for Step 2

Here are some tools that you can use when taking the step 2. During ECF4CLIM-project¹⁰, more tools are collected and tested by partners and demonstration sites.

Tools provided in ECF4CLIM-project concerning the step “Connections”

- Sustainability competence teams and committees (SCTs & SCCs)
 - Evocations: what sustainability means to me and my field?
 - Reflective diaries: how do we perceive and act with regards to sustainability in our daily practices

- Baseline assessments (WP 4)
 - Assessment of collective competences (Task 4.1), individual competences (Task 4.2) and environmental performance (Task 4.3)
 - Analysis on the results of the baseline assessments (Task 4.1-4.3)
 - Facilitating the work of Sustainability Competence Teams (SCT) and Sustainability Competence Committees (SCC) with co-design of measures to promote competences, behaviours and social practices towards climate action and sustainable development (Task 4.4)

- Digital platform to promote active learning and citizen involvement (WP7)
 - ECF4CLIM digital platform (Task 7.1 -7.2)

Questions for pedagogical reflection and development

Question related to systems thinking

- Why does environmental behaviour matter? How is our behaviour connected to global issues? How does our behaviour affect ecosystems? -> Life cycle thinking
- What kind of local issues and stakeholders are related to sustainability, and how to find out that? How can we deepen our understanding?
- What are the root causes of unsustainability? How are our current and visible problems connected to other problems?

Questions related to critical thinking

- What kind of information do we have about sustainability issues?

¹⁰ The ECF4CLIM process is described in the beginning of the report in the section About the project. More detailed description can be found in The ECF4CLIM process is described in the beginning of the report in the section About the project. More detailed description can be found in <https://www.ecf4clim.net/>. The project management plan: https://www.ecf4clim.net/files/ugd/1088b3_3a891432c1844fca8fb546b0a1056a04.pdf

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- What are the interests behind knowledge-sharing? Which values and hidden goals drive communication and knowledge production?
- How do our cultural background, values and assumptions influence our perception of sustainability?
- How can we promote understanding of different cultural backgrounds and contexts that have an impact on environmental behaviour?

Questions related to problem framing

- What are the most acute sustainability issues in our context? How can we make difference? What matters in our context?
- How could we frame our problem to design effective responses? How do you frame the problem personally? How do you frame the problem as a community?

Questions related to environmental performance

- Are there regulations by e.g., local educational administration that require promoting sustainability or measuring CO2 emissions?
- Are environmental impact, sustainability education or competences assessed, and are the assessments underpinned by regulatory requirements or recommendations?

Exercises, methods, models, and materials

- Draw a mind map or picture of all agents and factors of sustainability (Systems understanding of how our behaviour, as individuals and as a community is related to sustainability issues?)
- Map what sustainability issues you can directly or indirectly influence.
- Example: Article “The Ocean garbage patch is quite a mess” in Appendix 2.
- Young Reporters for the Environment, an international program encourages young people to perform investigative reporting, photography, and video journalism to connect a local environmental problem with a global environmental problem. The program offers materials to learn how to draft a report, make good pictures and videos and also launches a competition for students all over the globe. Students may participate individually or in groups. Through investigation, students learn the connections between environmental problems and with their possible solutions. <https://www.yre.global/>
- Spanish material: Calculations in circles. Apply circular economy criteria in actions of daily life, through the use of mathematics. https://www.naturalizaeducacion.org/sesion_doble/calculos-en-circulos/
- Romanian material: <https://www.edu.ro/educa%C8%9Bie-pentru-dezvoltare-durabil%C4%83>
- Finnish materials see MAPPA.fi -service

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Step 3 VISIONS: What are the possible futures in our context?

In the middle of current ecological and widening sustainability crises it is not easy to educate future generations to take responsibility of the issues that even adults seem not have the knowhow how to cope, make change and strive towards sustainability. Without visions we are driven to reinforce current unsustainable practices, ways of thinking, acting and reacting. Creating more sustainable collective reality necessitates visioning and mapping together the alternatives we have. We need to unleash our creative and intuitive faculties for seeing things differently, unlearning of unsustainability and learning while creating things that do not yet exist. This step on our map derives from GreenComp competence area Envisioning sustainable futures.

Envisioning sustainable futures in sustainability in GreenComp

Futures literacy

To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.

Adaptability

To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk. assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds

Exploratory thinking

To adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods.

Aims

This step aims at visioning preferred futures and reflect on likely futures and shorter-term scenarios related to possible trajectories, in the organizational context in question. It includes reflection on what kind of steps need to be taken in our context if the visions of the preferred future are to become reality. Schools and other educational organisations should foster emotional, cognitive, and behavioural adaptability by providing knowledge, promoting skills of coping with uncertainty, and encouraging action for transitions towards sustainability. Promotion of transdisciplinary knowing, e.g., integrating natural, social, psychological, artistic, and experiential knowing, can tap the creative and intuitive potentials for unlearning unsustainable ways of thinking. The whole community can act and learn while creating and learning things that do not exist yet.

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Content

The essential content of this step includes (a) visioning preferred and presumable futures and short-term scenarios, (b) promoting cognitive, emotional and behavioural adaptability, and (c) exploration through creative and relational knowing.

Envisioning likely and preferred futures and short-term scenarios

Future orientation is crucial for motivating people for sustainable changes and actions. Motivation to change increases alongside the realisation that the future is in our hands, as a society. For this reason, it is essential to envision preferred futures and compare these visions with the likely futures. In futures visioning, focus should be on what kind of future is expected based on the current trends and trajectories, what we want to avoid and what we wish to strive for. Moreover, envisioning short-term futures in the organizational context should build on the problem framings developed in the previous step of the roadmap. Visioning is important for creation of the strategy for action in the following step 4 of this roadmap.

At the level of individual competences, futures visioning promotes individual understanding of how the future lies in our common hands. From the individual perspective, it is relevant to reflect what everybody needs to do and change: How to realize the visions of a sustainable future in one's own life and in the community? Collective visioning might help to promote individuals' will to act in a more sustainable way within the organization.

At the level of collective competences, collective visions for sustainability foster the understanding that future is in our hands. Collective visions are a precondition for mutual strategies and plans. Collective visioning can focus on the questions of what kind of future is expected based on the current trends and trajectories, what we want to avoid and what to strive for. Besides, creating contextual short-term visions related to the problem framed previously, in step 2 of the roadmap, can help to create the strategy for action in the following step 4 of this roadmap.

At the level of environmental performance, an essential aspect of visioning is what kind of future is expected, based on the analysis of the current state of environmental issues on a general level and especially in the context of the organization. The core principle of creating a roadmap is to acknowledge what kind of changes and concrete actions are needed to improve the environmental performance of the organisation in question. Elaborating these visions demands knowledge about possible solutions.

Emotional, cognitive, and behavioural adaptability

Adaptability includes emotional, cognitive and behavioural aspects. Adaptability demands knowledge, skills and attitudes: how to cope with uncertainty and support transition towards sustainability? People are different, live in different contexts, and

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need different kinds of tools to promote their adaptability. Collective competences are essential in promoting individual adaptability because collective responses can enable or constrain individual adaptability.

At the level of individual competences, the emotional reactions have impact on learning and on the ability to change. Emotions in general either activate or passivate people. From a pedagogical perspective, it is essential to recognise that thinking about future can evoke uncomfortable feelings like ecoanxiety and ambiguity that are individual and need to be encountered in a supportive and safe atmosphere (Pihkala 2020). Knowledge about possible ways to reduce harmful environmental impacts and foster desirable change in society as individuals and as community is also essential. Facing inconvenient facts about future and realising the scale of changes needed in one's personal life can be stressful. Education can help finding ways to cope with such stress stemming from uncertainty.

At the level of collective competences, a caring atmosphere and concrete action for a more sustainable future can engender active hope and resilience among the involved individuals. Supportive listening and taking young people's worries about the future seriously helps individuals to choose positive coping strategies, and help to avoid indifference, depression and denial of the need for change. Fostering knowledge about possible change is an important task of communities. Focusing on success and positive consequences of actions in favour of sustainability can also help in adapting and coping with the fact that we are living in unsustainable societies: radical changes are inevitable for transitions towards sustainability.

From the perspective of environmental performance, also the environmental equipment and models can be examined in light of their adaptability. Developing structures that are more adaptable makes future changes easier. In addition, encouraging concrete action for sustainability of the educational institution via campaigns and by mapping the existing possibilities can engender hope.

Exploration through creative and relational knowing

Unleashing the creative potential of groups and individuals in promoting sustainability enhances adaptability and may help to identify completely new solutions. A creative approach to encountering sustainability challenges is essential as there are no simple solutions to the wicked sustainability problems that in essence necessitate widening understanding of knowing. Artful approaches are valuable for promoting not only creative problem-solving, but also for strengthening personal relations and ownership of these issues.

At the level of individual competences, it is essential to encourage and unleash individuals' creative and intuitive faculties for encountering the wicked sustainability issues. To solve such problems, we should learn issues on which we have very limited knowledge and skills. Creating novel solutions to novel wicked problems can foster

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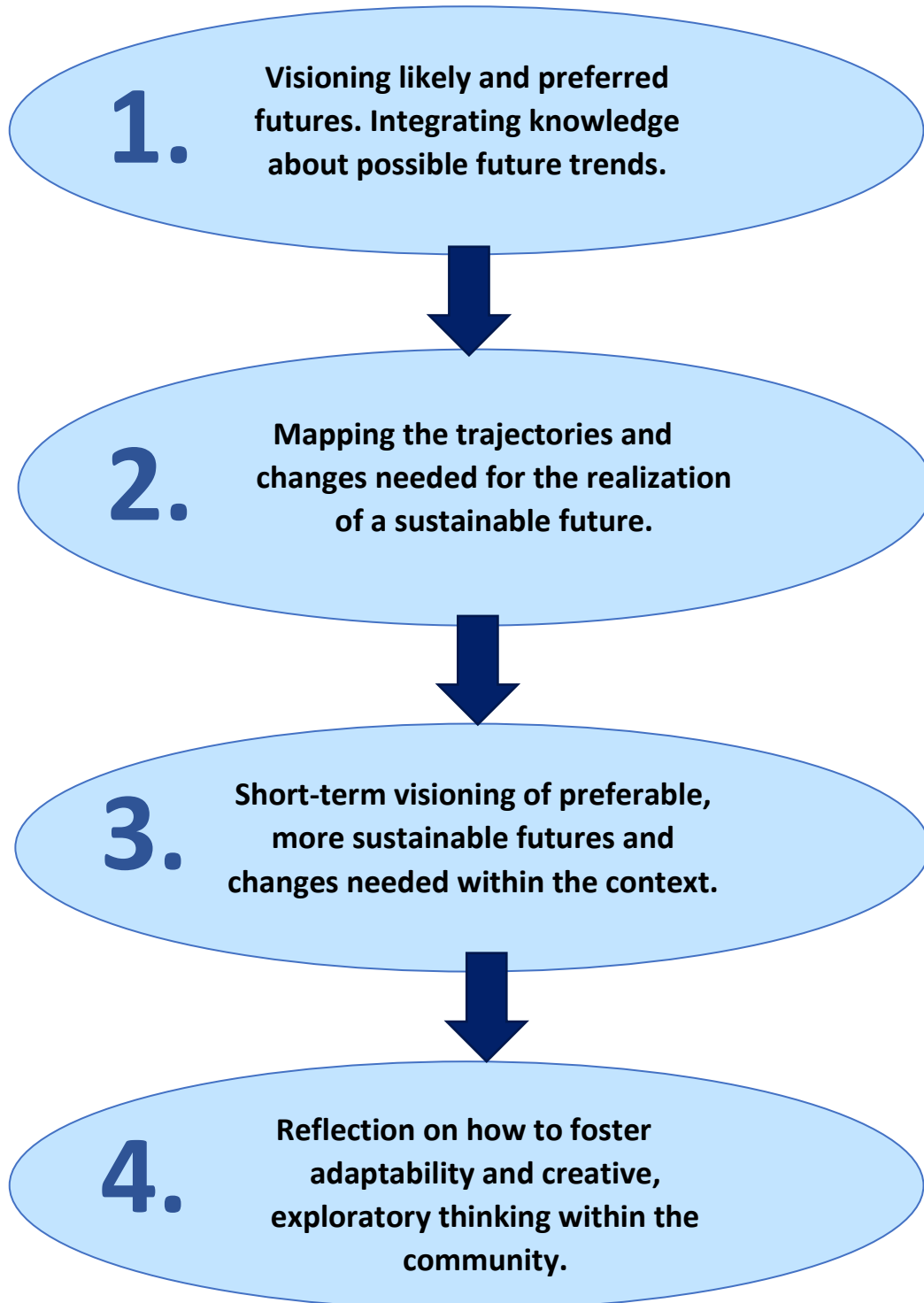
individual and collective learning. Transdisciplinary knowledge and systems understanding are also needed to find creative responses to sustainability that really matter. This kind of issue is for example how to turn the principles of circular economy into practice.

From the perspective of collective competences, communities have a crucial role in encouraging creative individual initiatives. Collective responses to creative individual initiatives can increase creative thinking among the community. Creative and artistic approaches should be included in curricula, and collective appreciation of other ways of knowing should be made explicit in everyday life of schools and other educational organisations.

From the perspective of environmental performance, creativity is necessary for envisioning and design of more sustainable ways of living and effective ways of engaging wider audiences to enhance sustainability. New technical innovations could be part of the solution, but not the only solution. For a more sustainable future, we cannot avoid the question of how to apply the principles of circular economy in different contexts.

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An example of the process how to proceed in visioning futures



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Constraints and enablers concerning POSSIBILITIES AND VISION

This step on the roadmap could reveal contradictions between new ideas of activity and former established practice of the organisation (cf. Engeström 1987; Engeström & Sannino 2010). Knowing previous trajectories and visioning together possible futures helps individuals and the school or other educational organisation adapt to change. Bringing creative approaches and other ways of knowing to the stage can ease the disturbances that unavoidably emerge while experimenting the new ideas. Emerging disturbances are important: If nobody notices the change, there is no real change. The possible enablers and constraints of the step 3 are summarized in the following figure.

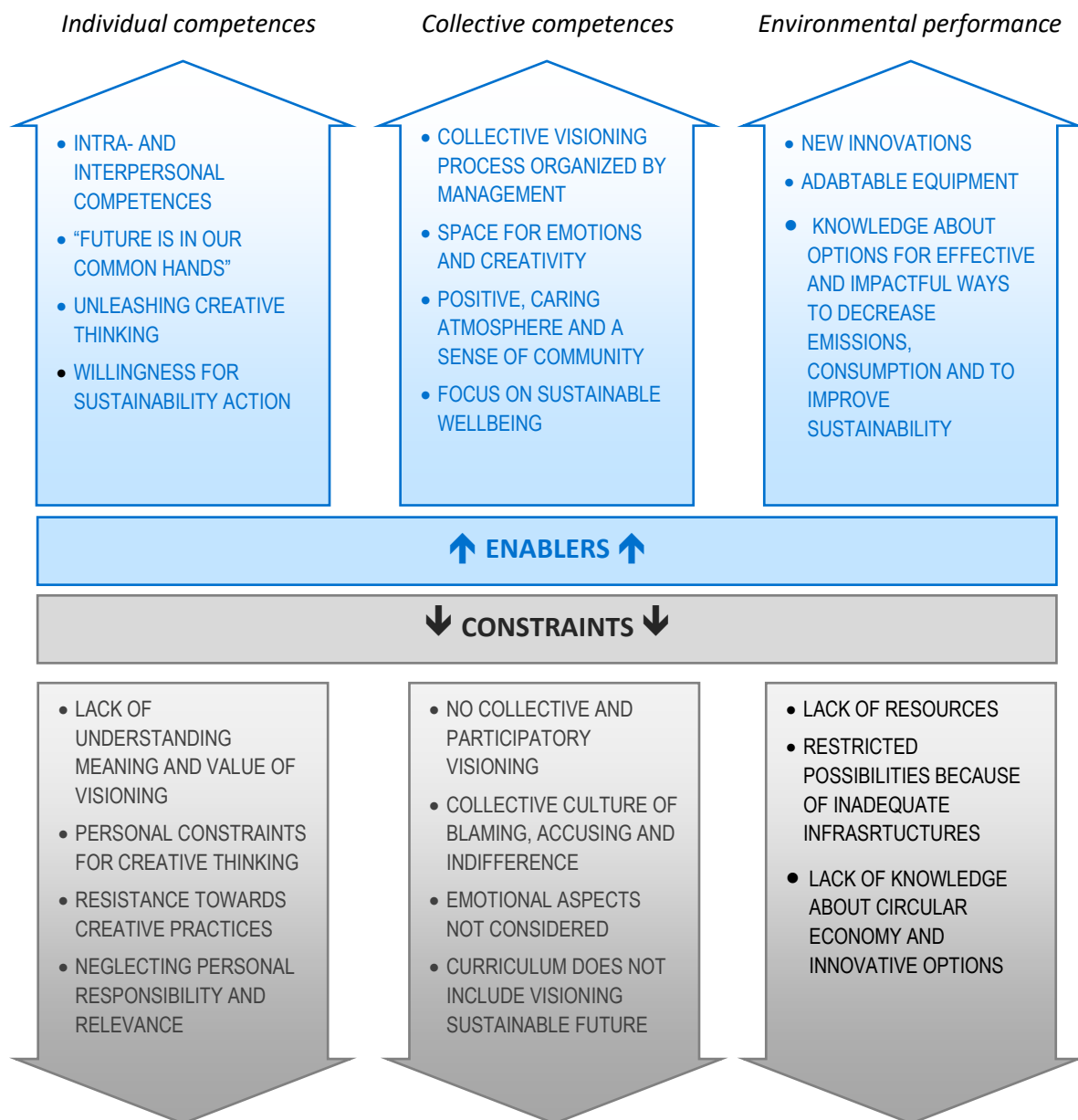


Figure 5. In the field of engagement, what could enable or hinder work towards sustainability

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Tools for Step 3

Tools provided in ECF4CLIM-project to the step “Possibilities and visions”

- Development of an ECF for climate change and sustainable development (WP3)
 - Participatory will formation: crowdsourcing methods Dream school workshops (Task 3.1) and contextual visioning
 - Development of ECF (Tasks 3.3-3.5)
 - The roadmap for promoting sustainability competences in education (This document)

Questions for pedagogical reflection and development

Related to visioning:

- What kind of future alternatives do we have?
- Acknowledge the (micro, meso & macro level) trends having impact on our future.
- What do we want to strive for (related to the problem we framed in the previous phase)?
- What kind of actions are essential and needed for the preferred sustainable future?
- What constrains and enables the change? What kind of visions of future does the curriculum include or reflect?
- What kind of things need to happen for the visions of the preferred future to become reality?

Questions related to adaptability:

- How to promote behavioural, cognitive and emotional adaptation?
- How to promote a sense of hope while teaching about the serious impacts of e.g., climate change?
- How to cope with uncertainty, contradictions and trade-offs and support transition towards sustainability?
- What would be the essential concrete and impactful actions?
- What kind examples of success in promoting sustainability could we use?
- How to unleash and use our creative and intuitive potentials for learning in creating things that do not exist yet?

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Exercises, methods, models, and materials

- *Visioning a preferable, more sustainable future:* Imagine living in the year e.g. 2072. Back-casting decades: what kind of trajectories are necessary for the realization of the jointly outlined more sustainable future? Reflection on the enablers and constraints for promoting sustainability (in education) related to individual, collective competences and environmental performance. This phase is essential for the following step 4. of strategies and action.
- *Tool for reflection on emotions:* What kind of images and emotions does thinking about future evoke? (In the beginning of the process, in between and in the end) Personal emotional reflection through e.g., drawing images, free associative writing or chatting with a pair. It is reasonable to integrate some physical activities like walking during or after emotionally intensive practices. Emotions are embodied and embodied activities are helpful for their release.
- Suitable pedagogical approaches
 - Circular economy, design science
 - Inquiry-based learning on real sustainability issues to promote relational ways of knowing
 - Emotional adaptation, steps of encountering environmental and climate anxiety in environmental education (Pihkala 2020)
 - Active hope, by Joanna Macy.
 - Education for hope, by David Hicks.
- Spanish material: Attention! future under construction. Introduce the concept of socio-environmental collapse as the main challenge that we have to address and on which it is possible to intervene.
https://www.naturalizaeducacion.org/sesion_doble/atencion-futuro-en-construccion/
- Romanian material: <https://www.edu.ro/planuri-de-lec%C8%9Bii-edd>
- Finnish materials see MAPPA.fi -service.

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Step 4. ACTION: How to proceed?

We can guess that nobody would like to have an ecologically sustainable future. Framing the problems and visioning good and acceptable solutions are a bit harder tasks. However, our success depends on our ability to “walk the talk”. Promoting sustainability at school or in other educational organisations happens/takes place and has impact on many levels. Acting for sustainability at a school or another organisation includes individual initiatives among students, teachers and other staff. However, the change is not possible without collective action. If we want to promote changes across society through education, educational organisations need to have political and societal agency. On each of these levels, we need both individual and collective competences. While acting, we should also keep in our mind the environmental performance and environmental impact of our actions. This step on our map derives from GreenComp competence area Acting for sustainability in sustainability.

Acting for sustainability in GreenComp

Political agency

To navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability.

Collective action

To act for change in collaboration with others.

Individual initiative

To identify own potential for sustainability and to actively contribute to improving prospects for the community and the planet.

Aims

The aim of this step is to proceed to action by using the knowledge we have gained during the previous phases. Designing and evaluating action for sustainability should be related to the previous phases¹¹: values and principles, systems understanding and framing of the problem, and our vision. To implement and realise the visions elaborated in step 3, strategies and action plans are needed. Assessment of the results is an essential part of action. During the implementation, we also acquire competences (knowledge, skills, and attitudes) on how to make our actions effective and meaningful, and how to assess the results, taking into account our context, values and visions of the more sustainable futures.

¹¹ In the Appendix 1, you can summon the main results and points of all the steps to help constructing the strategy.

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Contents

In this step of strategies and action, at least the following three issues¹² are central in promoting sustainability in education: (a) Structures for change; (b) Creating strategy and action plan; and (c) Resources for change.

Structures for change

To have permanent changes in an educational organisation, the new ways of doing should be embedded in the everyday life. All members of the community should be invited to take part in the development process, in elaborating acceptable procedures for all. In addition, there should be permanent structures in the administration and working teams that have the right and responsibility to promote sustainability. This step is closely connected to the step 1, where values were scrutinized from viewpoints of different kinds of stakeholders and actors, and step 2, where all the relevant stakeholders were mapped.

At the level of individual competences, principals, and other leaders of the organisation are in a crucial role. Leaders' knowledge, skills and attitudes affect the ways in which different values and goals of education are prioritised, sustainability being only one issue among many others. One person can be attributed the task of promoting ecological sustainability, and this person's competence is very relevant for the whole organisation. This person can educate other teachers and staff on sustainability issues. Usually, mainly those who are the most interested in sustainability and have most knowhow attend training courses held outside of the school.

From the perspective of collective competences, it is important to remember that persons in charge of sustainability cannot make organisation sustainable alone/by their own. Participatory approaches to planning collective action are crucial. A permanent team for sustainable issues can develop educational organisation persistently and more effectively. All individuals in the team form swarm intelligence: all members together have competence that none of the members have by their own and form collective strength of the organisation. Mapping the individual strengths and analysing the current collective ways of acting and talking related to sustainability could be useful.

At the level of environmental performance, essential structures enabling sustainable actions might be missing. For example, it is hard to recycle waste if there is no local system for recycling, or even if recycling bins are available, cleaners may have an employment contract that does not include emptying multiple trash bins. There could be also contracts for delivery that limit the school's possibility to purchase environmentally friendly products. In these cases, political agency and competence are

¹² These have arisen from crowdsourcing, document analysis of ECF4CLIM-project and GreenComp.

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needed: how to change contracts, develop the local infrastructure and act for change in collaboration with others?

All these levels are intertwined: Persons working in sustainability teams need to acquire individual competences, and the missing structures can be under decision-making powers of the leaders of the educational organisation.

Action plan

Without an action plan, which strategically and proactively examines possible ways of progressing in the long term, the development of practices will remain short-sighted and reactive. Participatory and inclusive approach (described in the Step 1 and in the previous part, Structures for change) should be the guiding principle in designing a strategy for concrete action and evaluation. Contents of the strategy and the action plan follow on from the previous visioning sustainable possibilities (step 3). In the Appendix 1, you can find a table for summarising the results and key points of all the steps to help constructing the action plan.

At the level of individual competences, knowledge about the environment (look also Step 1) and systems (look also Step 2) and skills of teamwork are needed for the design of the most effective actions. Skills, knowledge and attitudes evolve during the planning work, and all the actors in the community (students, teachers, leaders, other staff) should be involved in this learning process.

At the level of collective competences, strategy and concrete action plan should be brought into collective discussion and under common decisions. The plan should clarify goals, roles in sustainability work and include responsibilities: who does what with whom, when and with which resources (about resources in the next section), and how the results are evaluated. Planned activities should be connected with subject matters in different subjects and courses. There are programs, like the international Eco-School program¹³, that can offer support in planning the concrete goals and activities. It is useful to connect the local plan with the other national and local regulation and norms which steer the work of the educational organisation. Also mapping possibilities to participate in societal transformations is a viewpoint that should be included. Furthermore, concrete action for promoting adaptability, and for strengthening a sense of hope and positive collective atmosphere could be included in the roadmap.

At the level of environmental performance, it is useful to describe in the plan how the planned actions are expected to reduce harmful environmental impacts. If the plan includes for example technical procurements, calculations are useful: is the environmental impact of producing the equipment below the impact that the problem itself produces. Here competences of systems thinking and critical thinking (see also

¹³ More information on Eco-Schools: <https://www.ecoschools.global/>

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Step 2) are valuable. Calculations can also help to choose between alternative possible actions.

All these levels are intertwined: individual competences of the members of a planning team and calculations of impacts of actions affect what kind of possibilities are chosen for concrete actions.

Resources

Possibilities for change often depend on resources. These can include monetary resources for procurements or salaries, time for planning and action, pedagogical tools and models, or personal skills, knowledge, and abilities. Resources are connected to adaptability described in Step 3. Allocation of resources and prioritisation reflect the values prevailing in the organisation (see Step 1). Some resources could be acquired through reallocating existing resources or through projects. The constantly developing pedagogical toolbox including methods and models of activity is one essential resource.

At the level of individual competences, personal resources define/enable or constrain what kind of individual initiatives one can undertake. It is important to identify one's own potential and possibilities to have an impact on sustainability. Knowing one's own strengths and limits, and learning to advance to higher levels, helps an individual to actively contribute to sustainability. Wellbeing is important for action competence and is in turn fostered by a positive emotional atmosphere – a cultural-cognitive collective competence that is also relevant for adaptability (See also Step 3 and adaptability). Further training increases personal resources.

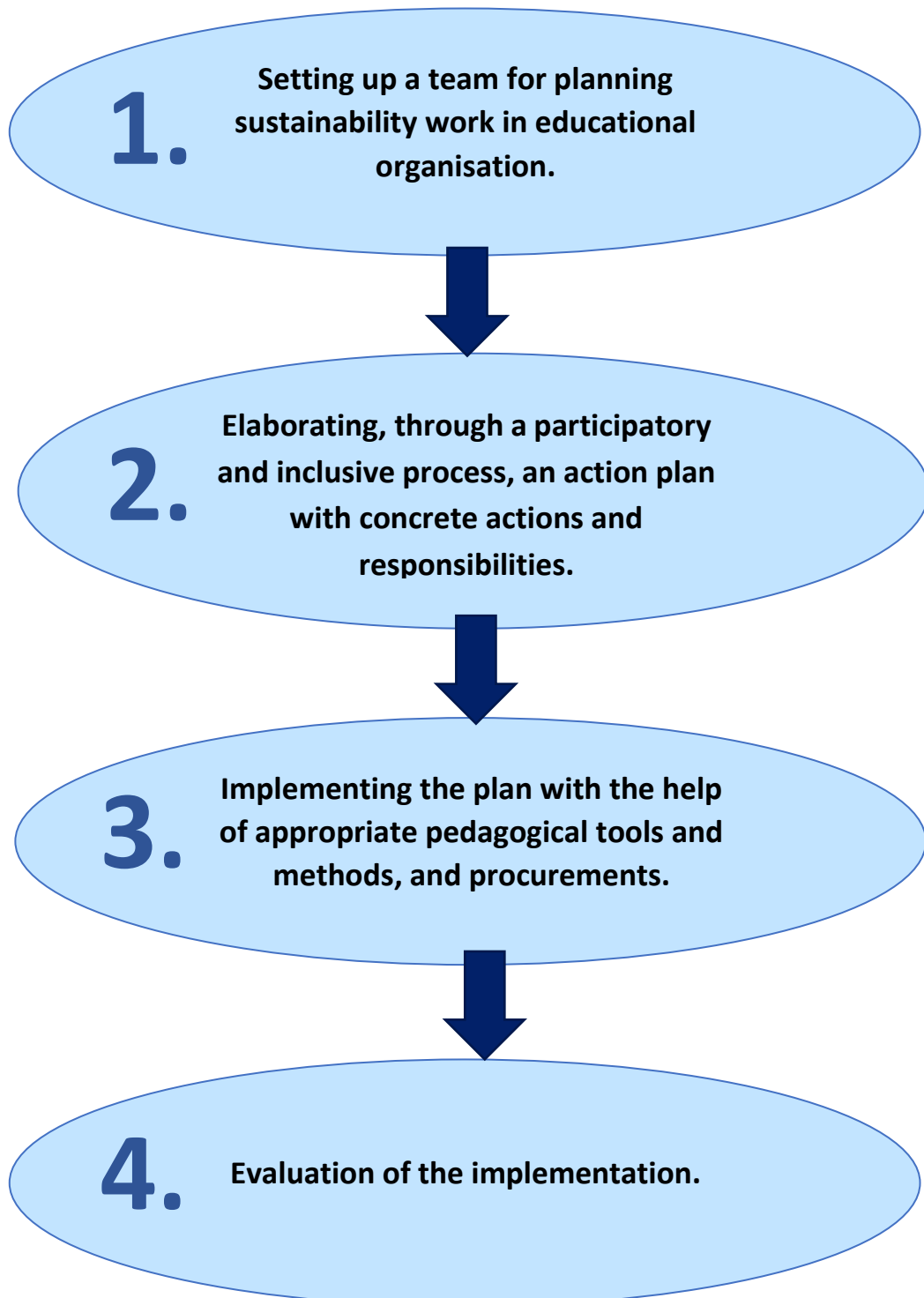
At the level of collective competences, allocation of resources to sustainability issues can be made by decisions or steering of educational organisations. For example, in Finland, universities and universities of applied sciences must conclude with the Ministry of Education a contract specifying how they plan to use the resources from the government. The supply of pedagogical tools, materials and models construct collective competence. There are remarkable differences between countries in resources that are used and can be used in education and infrastructure, so the starting points vary. This must be considered.

At the level of environmental performance, procurement of meters and energy-saving equipment require monetary investments. There can be contextual constraints: in some countries, corruption can draw considerable amounts of resources, while in other countries, rigid bureaucracy may constrain changes in resource allocation.

All these levels are intertwined: scarce resources of the organisation on development of sustainability education, or inadequate material tools to reduce harmful environmental impacts, can diminish wellbeing of staff in educational organisations, and thus undermine individual initiatives.

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An example of the process



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Constraints and enablers concerning ACTION

This step on the roadmap could reveal contradictions between the implementation of new models of activity (cf. Engeström 1987; Engeström & Sannino 2010), visioned with previous step 3 and planned with step 4, and activities of other actors. For example, textbook publishers might not have contents adapted for new kinds of learning, or cleaning-service providers may not have the resources needed for recycling. Changes in the educational organisation generate a need for changes for other actors. This could create inconvenient situations but could also plant a seed for a larger societal change.

As a summary of the step 4, there are some factors that could hinder or enable the work towards action for sustainability in educational organisations.

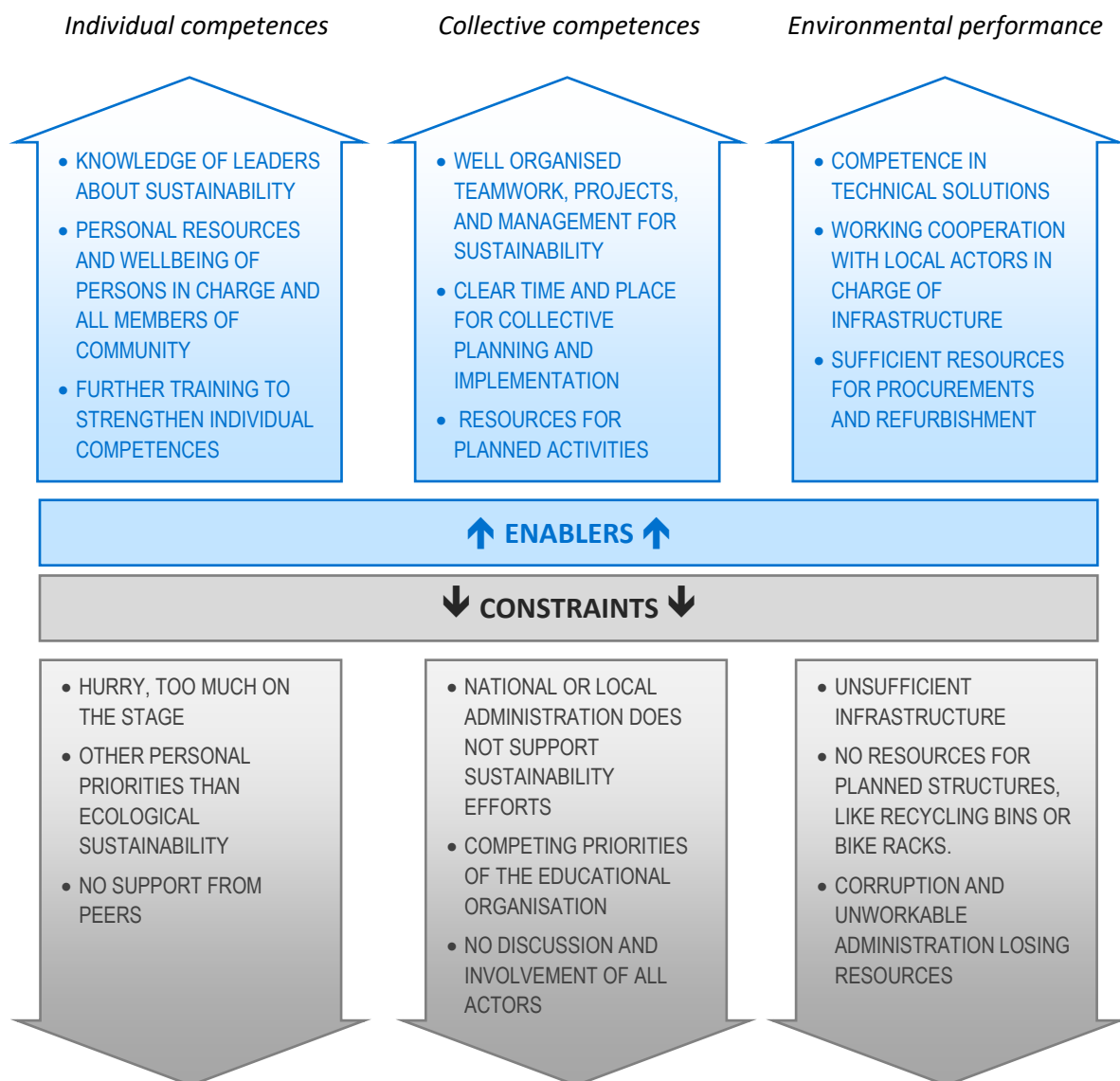


Figure 6. In the field of strategy and action, what could enable or hinder work towards sustainability

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Tools for Step 4

Here are some tools which you can use when taking the step 4. During ECF4CLIM-project, more tools are collected and tested by partners and demonstration sites.

Tools provided in ECF4CLIM-project to the step “Action”

- Development of an ECF (European Competence Framework) for climate change and sustainability: challenges and opportunities (WP3)
 - Development of an ECF (Tasks 3.3-3.5)
 - The roadmap for promoting sustainability competences in education (This document)
 - Facilitating the work of Sustainability Competence Teams (SCT) and Sustainability Competence Committees (SCC) with co-design of measures to promote competences, behaviours and social practices towards climate action and sustainable development (Task 4.4)
- Testing the ECF: evaluation (WP6)
 - Evaluation methods for the collective and individual competences, environmental performance, and participatory processes (Tasks 6.1-6.4)
- Digital platform to promote active learning and citizen involvement (WP7)
 - ECF4CLIM digital platform (Tasks 7.1 -7.2)

Questions for pedagogical reflection and development

- What constrains and enables sustainability in your context? How do you have to take the constraints into account, and how can you take advantage of enablers in planning of actions?
- Where to have focus in practicing action? What can we have an impact on? What can we decide? What can we not decide, but can have an impact on? What can we neither have impact on nor decide?
- How can we promote inclusive collaboration for sustainability?
- What kind of new actions, regulations, relations, discourses, communication practices do we need to promote sustainability?
- How could our activities have an impact on the whole society?

Exercises, methods, models, and materials

- Roadmap table (Appendix 1), for summarising the key points and results of all the steps to help constructing the strategy.
- Sustainable development certification of educational establishments in Finland <https://koulujaymparisto.fi/in-english/>

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- Activities for teaching Action. Rounder Sense of Purpose. The RSP Partnership, c/o University of Gloucestershire, UK.
<https://arundersenseofpurpose.eu/framework/at-pra/>
- Eco-schools program <https://www.ecoschools.global/>
- Sustainable Schools. Best Practices Guide. Ministry of education. British Columbia. <https://www2.gov.bc.ca/assets/gov/education/kindergarten-to-grade-12/teach/teaching-tools/environmental-learning/sustbestpractices.pdf>
- A tons of tips for effective team work from Google search, use for example words “methods of effective team work”
- Spanish materials
 - Verbs that impact. Know the consequences of our daily actions on the environment to propose alternatives for its care and maintenance. https://www.naturalizaeducacion.org/sesion_doble/verbos-que-impactan/
 - LIBERA Classrooms. It is an environmental education project to raise awareness of the GARBAGE problem in all educational centers that want to be part of this initiative. <https://proyectolibera.org/aulas-libera/>
 - Environmental Seal Sustainable Educational Center – Regional Counselling of Environment, Housing and Land Management of Castilla y León. <https://medioambiente.jcyl.es/web/es/participacion-educacion-ambiental/sello-ambiental-centro-educativo.html>
- Romanian material: <https://www.edu.ro/planuri-de-lec%C8%9Bii-edd>
- Finnish materials see MAPPÄ.fi -service, for example:
 - Keke koulussa -kestävän kehityksen opas/Sustainable development guide for schools <https://mappa.fi/materiaalit/keke-koulussa-kestavan-kehityksen-opas/>

6. CONCLUDING REMARKS

This report introduces an initial European Competence Framework (ECF) aimed at enabling the education community to take action against climate change and towards sustainable development. This initial ECF is structured along the lines of the GreenComp developed by the Joint Research Center of the European Commission (Bianchi & al. 2022). However, this report further develops the competences outlined in the GreenComp and operationalizes them in the form of a roadmap. It aims to provide tools for different stakeholders to foster the enablers and overcome the constraints of sustainability in various educational contexts. The roadmap draws from the ECF4CLIM crowdsourcing results that indicated relevant factors that enable and constrain promoting sustainability. Additionally, the analysis of literature and policy frameworks presented in deliverable 3.2 have provided relevant information about sustainability competences for the process of creating the roadmap. The initial ECF brings together the needs, enablers, and tools for countering the constraints that were identified by the participants of the crowdsourcing exercise, designed to facilitate a participatory process to engage people from different perspectives.

Promoting sustainability through education is a complex challenge. On one hand, we must recognize that we are facing a complex set of wicked problems which need to be tackled on multiple fronts at the same time. On the other hand, it is clear that not all the necessary changes can be done at once. The intention of this roadmap is to help the readers to find the concrete ways how and where to begin the change in their context. The roadmap hopefully helps teachers and education experts to create visions and a purposeful strategy on how to promote sustainability in practice in the specific context and how to evaluate it.

Through a participatory approach we can facilitate learners' abilities to name and frame their own ideas and concerns about our future, and their position and potential for change. Focusing on the positive aspects of sustainability can increase people's sense of wellbeing and meaningfulness. A school or university that takes sustainability as a core principle, can focus on advancing planetary wellbeing for students, teachers, communities, nations, ecosystems and the planetary biosphere. Positive focus on fostering collective atmosphere of care and success in sustainability can feed motivation to change and act. Creating a roadmap becomes meaningful only when it becomes connected to practice; the actions and activities people do in their everyday lives.

However, understanding how to act is a necessary but not sufficient condition for change. Humanity faces sustainability crises that accumulate and accelerate right before our eyes, which may result in anxiety, depression, and paralysis of some individuals, resulting in a complete loss of the ability to act in a meaningful way. Many of the crowdsourcing participants posed the question: how to empower and encourage people; how to cultivate care and hope while taking the gravity of the global situation



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seriously within our educational community? Moving forward, we need sustainable hope, based on the recognition of facts. Sustainable hope also requires the ability to envision positive prospects for the future. Promotion of sustainable hope is one of the most essential elements of this roadmap.

This initial roadmap is not our final proposal for possible roads and routes to a sustainable future. During the ECF4CLIM-project (2001-2025) the vision about the constraints, enablers, possibilities, processes, and even goals for sustainability in educational setting will be further clarified and reassessed. At the end of the project, a more sophisticated and tested version of the ECF will be presented for further development. An easy-to-use website of the roadmap will be constructed at a later stage to enable larger audiences engage in its further development.

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Appendix 1. Table for summarising the key points and conclusions of each step of the roadmap.

Basis	UNDERSTANDING OF HUMAN DEPENDENCE OF ECOSYSTEMS' WELLBEING as the starting point		
Step 1 ENGAGEMENT	Values Personal level: Community:	Needs Personal level: Community:	Principles of the participatory process:
Step 2 CONNECTIONS	Current state Sustainability issues on Personal level: Community: Societal: Global:	How do we frame the problem?	Cultural aspect Assumptions: Personal Collective
Step 3 VISIONS	Dream of sustainability Individual level: Community: Societal: Global:	Changes that need to happen Individual level: Community: Societal: Global:	Plausible futures (Trends & trajectories) Individual level: Community: Societal: Global:
Step 4 ACTION	Resources: Available Missing	STRATEGY Who? What? Where? (Structures) How?	Enablers: Constraints: What can we have impact on and what can we decide?
	EVALUATION related to all the steps.		

Appendix 2. An example material for teaching complexity

The Ocean garbage patch is quite a mess

Niina Mykrä

Published in Finnish in the journal "Ympäristökasvatus 2022" (Environmental education 2022)

Far away in the ocean is a large patch of waste. Images of "plastic soup" and dead birds with bellies full of plastic have become engrained in the minds of many of us as nightmares. But fortunately, we know how to deposit garbage in the correct bin, our waste management functions, and we are on our way towards solving rather than making this problem worse. Or are we?

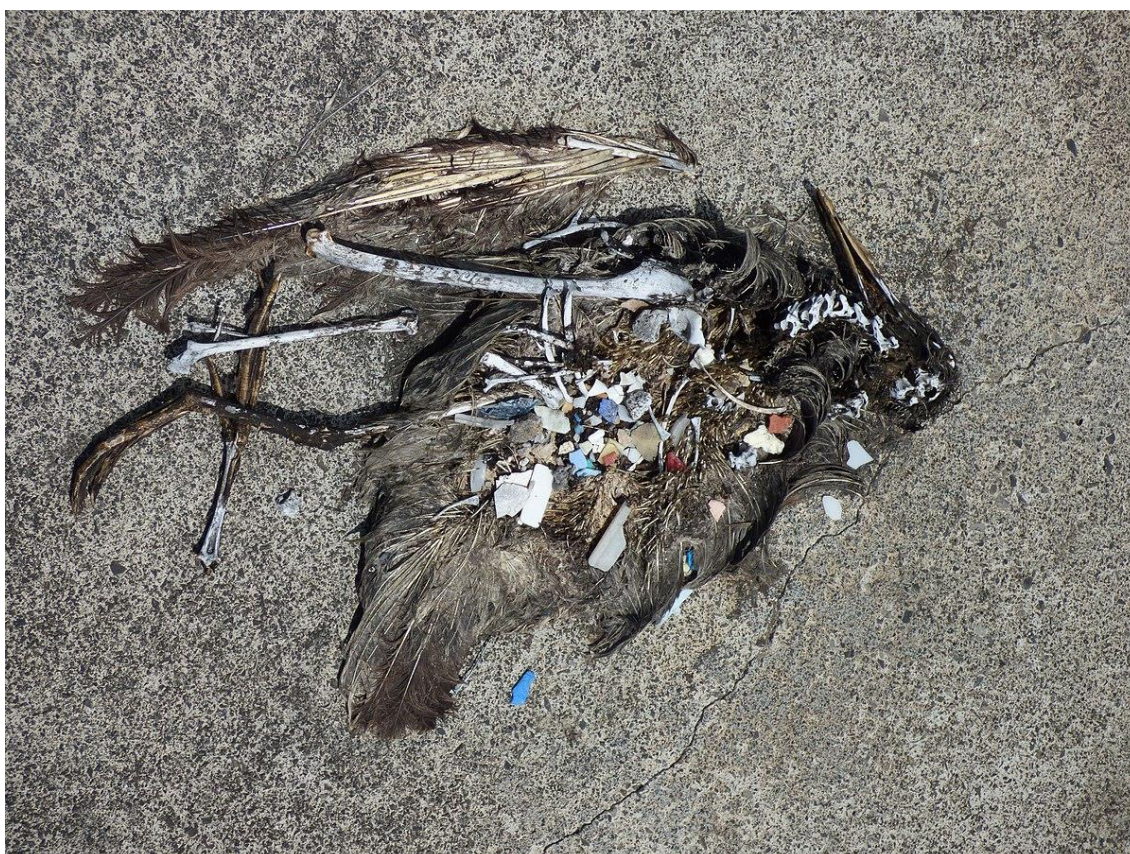


Photo: Forest and Kim Starr (Wikimedia CC-BY-3.0-US)

I ride by car to the local grocery and grab a ready-made tuna salad to my plastic sports bag on the way to the soccer fields. I put on the workout clothes I just bought at discount and feel bad about the disposable packaging of the salad. What makes things easier is that there is a sorting bin for the plastic cover in the corner of the hall. I throw my training clothes to the laundry machine, take a shower, and finish off with a layer of face scrub. The day is over.

This seemingly mundane episode - one of many - is a small knot in a thread that stretches around Tellus. The tentacles reach all the way to the waste patches of the seas.

The lid of my salad package is one example of the ten most frequently found types of plastic litter on the beaches of the EU countries. In addition to food packaging, the beaches are littered by disposable cups, cutlery and other dishes, various cotton products containing plastic, plastic sticks and straws, cigarette filters, plastic bags, and

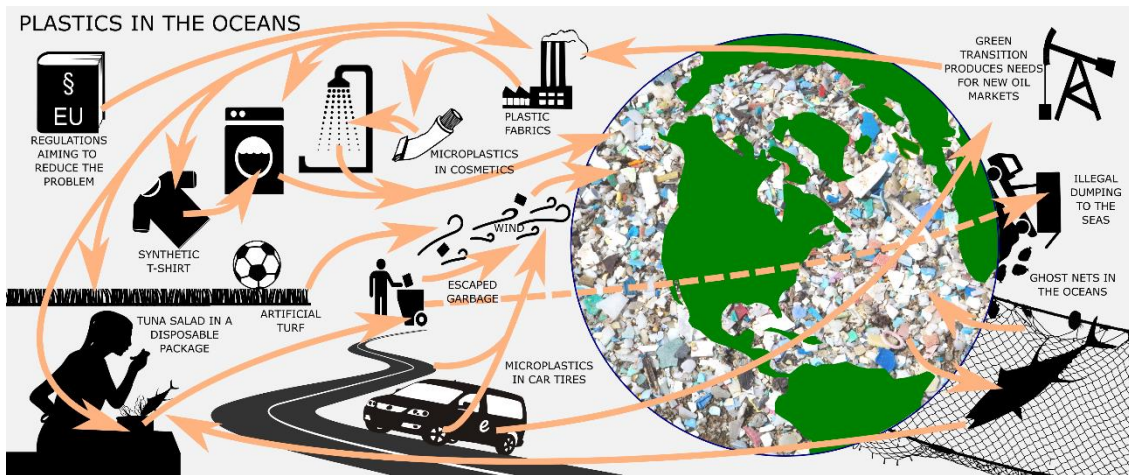


Image collage N. Mykrä, images: Josophtr CC BY-SA 4.0, N. Nijaki CC BY-SA 3.0 (Wikimedia Commons), and Public Domain CCO

plastic bottles. The EU is trying to improve the situation with new regulations targeting these products. The lid, and especially the small bag of salad dressing that came with my salad, may be blown away by the wind, from the garbage or sorting center, and then be carried away by waterways to the sea. Garbage that ends up on streets in winter can also find its way to the sea, given that dumping in the sea is a common practice of getting rid of the snow ploughed from the streets.

Even if the plastic is recycled, a large part of the sorted plastic ends up being incinerated: to qualify for plastic production, the recycled material needs to be of consistent quality. On the one hand, waste incineration generates emissions, while on the other, the energy produced through incineration – as well as the price of energy – may discourage people from recycling the waste as material. Incineration of plastic waste has increased because many developing countries that used to receive plastic waste no longer accept to serve as rubbish dumps for Western countries. Illegal waste trade is still able to circumvent the waste dumping ban. In poor countries, with their underdeveloped waste management systems, only a part of the collected plastic can be reused, and a lot of the waste is discarded into nature. These countries seldom have the resources to prevent and effectively address the plastic problem.

Money and economic interests play a vital role in the plastic problem. Oil companies dominate the plastic trade. As the energy use of oil is likely to decrease with the green transition, oil companies are seeking to divert oil from energy use to plastic production. For this, the companies need to identify and create new plastic market opportunities. The wealthy consumers can always afford to buy new products, and this consumption results in ever greater amounts of discarded plastic products. On the other hand, the less wealthy also want to keep up with the trends, searching for the cheapest possible product. Yet, a product can only be cheap if workers in its production process are paid poorly, the environment is not taken care of and the product quality is mediocre, at best. The synthetic fibre training shirt that I bought at discount will quickly wear out and become plastic waste.

Even the food inside the disposable packaging is part of the waste problem. My tuna is caught with a net or other fishing gear made of plastic, which end up in the sea in large quantities: they are either thrown into the sea once they have become unusable or they simply break down and escape from the owner. Such “ghost nets” kill large numbers of fish and other marine life. Both during use and after having been abandoned, nets release microplastics, with increasing plastic load in the oceans as a result.

When I drive a car, its tires wear out. A bigger source of microplastic than nets in the sea is the microplastic released from car tyres. Microplastics also come off the artificial turf on the soccer field where I train. These particles are transported to the sea along with stormwater, for example. Microplastic is leached into the sea also when I wash my training clothes or other textiles that contain artificial fibre. My face scrub, like many other hygiene and chemical products, contain microplastics. The significant amount of microplastic that wastewater treatment cannot remove is transported via the water cycle into the oceans.

The direction of flow is not only microplastic from me and the products I use to the sea, but also the other way around – from the sea to me. Ninety percent of the sea salt used as table salt contains microplastics. Ocean fish has also been found to contain microplastic. A salad with salt and fish brings the waste problem literally right into me.

My ordinary training day hence turns out to be unnervingly complicated and intractable, with its multiple connections and dilemmas. The new European reference framework for sustainability competence GreenComp names the acceptance of complexity as one of the key aspects of sustainability competences. Accepting complexity requires systemic and critical thinking and stresses the importance of problem definition: The plastic problem extends from individuals to organizations and systems across the planet. A critical examination of the lifecycle of plastic reveals that the biggest problem is not the plastic waste but its production and consumption. Equipment that collects plastic from the seas also collects living organisms, so they are not a solution but part of the problem. The transformation of our culture, which uses plastic excessively, towards a more sustainable one requires that both individuals and communities have the skills and understanding of the complexities involved.

What Ocean Garbage Patch?

There are actually five large waste patches floating in the seas. Plastic waste accumulates in the patches to the Pacific and Atlantic Ocean currents. The largest – the Great Pacific Garbage Patch – is estimated to be three times the size of France and weigh as much as 500 jumbo jets. Furthermore, the vast majority of plastic in the sea is at the bottom or under water, broken into small and even nano-sized particles. The amount of plastic waste in the sea is constantly increasing. Scientists have estimated that in 2050 there may be more plastic than fish in the world's seas and oceans.

Many marine animals mistake plastic for fish or other food. Pieces of plastic end up in their digestive tracts, and even tiny plankton try to use microplastics for food. Through food chains, plastic also finds its way on our dinner plates. Plastic waste has negatively affected nearly ninety percent of marine species. This can happen when marine animals ingest plastic, but also when they become trapped or suffocate in plastic debris. When the sun breaks down plastic into ever smaller particles, harmful chemicals are released. Some plants, insects, crabs and molluscs that usually live on the beach are able to form new ecosystems due to the plastic waste. Through plastics, species even move from one continent to another, in which case new alien species may displace native species. The full effects of plastic waste on ecosystems and humans are not even known yet.

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