Chapter 27
Teaching and Learning in Sustainability Science

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Abstract The concept of sustainability does not present *the* pathway or distinctive solution which needs to be followed and is defined differently by different actors around the globe. Thus, the transition towards sustainability relies on constant negotiation and societal learning processes. To achieve this, education and learning must be seen as key processes. It is the area of education for sustainable development that is concerned with aspects of learning that enhance the transition towards sustainability – an area that can best be described as a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the Earth's natural resources. This chapter elaborates upon how education for sustainable development translates research outcomes of sustainability science into educational practices and guides the selection of learning objectives, relevant content and appropriate forms of teaching and learning.

Keywords Education for sustainable development • Competence development • Self-directed learning • Collaborative learning • Problem-based learning

1 Introduction

In sustainability science, a consensus exists that we are living in a time of transformation, in which a global range of social, economic, cultural and ecological changes occur on levels rarely seen before, threatening a number of 'planetary boundaries' in the long term (Rockström et al. 2009). Over the last few decades, a growing awareness of these unsustainable changes has emerged within the general public, as well as in politics, and the concept of sustainable development was introduced into the public discourse. This concept offers an orientation towards what a transformation within 'safe and just boundaries' (Raworth 2012) could look like. At the same time, sustainability does not present *the* pathway or distinctive solution which needs

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to be followed. As an 'ill-defined concept' (Laws et al. 2004) and a 'moving target' (Hjorth and Bagheri 2006) that is defined differently by different actors around the globe, the transition towards sustainability relies on constant negotiation and *societal learning processes*.

Both at the individual and global levels, what we need to learn is how to improve our capacity to adapt to inevitable changes and to mitigate the future consequences of today's actions. This necessitates a shift in mindsets that goes beyond 'doing things better' or 'doing things differently' towards a paradigm change of learning to alter the way we look at things completely. To achieve this, education and learning must be seen as key. Not surprisingly, education features prominently in various declarations, visions and missions around the world as a soft measure for bringing about change.

Important Facts
Education is repeatedly referred to as a *soft* measure for achieving sustainability. This is based on a distinction between 'hard' instrumental measures and 'soft' persuasive measures seeking to bring change. Hard measures include legislative, regulatory and juridical, as well as financial and market instruments – many of which are discussed in earlier chapters of this book. Besides education, it is, e.g. social marketing and media campaigning that comprises persuasive approaches of soft measures.

It is the area of education for sustainable development that is concerned with aspects of learning that enhance the transition towards sustainability. Education for sustainable development can best be described as a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the Earth's natural resources. It translates research outcomes of sustainability science into educational practices and guides the selection of learning objectives, relevant content and appropriate forms of teaching and learning.

2 What Are We Learning For?

- **Task**: *Before we elaborate on the role of education and learning objectives in education for sustainable development, take a moment to reflect for yourself: what is the role you think education can or should play for a more sustainable future? What are the learning objectives you would hope to be met in education for sustainable development? Make notes of what you think of as most important in this regard, then read this chapter and come back to your notes. Would you reconsider your first impression?*

As the answer to this question will ultimately influence the way content and learning and teaching methods are chosen and designed, we need to think carefully

Box 27.1: The Opposing Poles of Instrumental Versus Emancipatory Approaches

Instrumental approaches, which are most commonly found in policy papers and among politicians, focus on the achievement of sustainable development. Here, it is argued that sustainability is an important societal objective and education thus must contribute to achieving this objective. Consequently, education is interpreted as a means to achieving an end – that of sustainability.

On the other side in that debate, *emancipatory approaches* argue that what must be considered is the free will of the autonomous learner. Education in that sense is not about giving directives, but about offering learning opportunities in which the individual can develop. Sustainability thus is not the ultimate goal of education, but a learning context to support broader educational goals.

about what we try to reach with education for sustainable development. In the academic world, a debate arose about the question of how education should relate to the concept of sustainable development and what outcomes education should be aiming at. This question reconsiders the role education in general can and should play for a more sustainable future. Two opposing positions, deeply critical of each other, inform this debate, namely, the instrumental and the emancipatory (see Box 27.1).

The two positions mark fundamentally different approaches and can be found on opposite poles. However, in reality, it is not so much of an either/or situation, as there is a variety of approaches that lie in between, some of them of a more instrumental and others of a more emancipatory nature (Wals et al. 2008). And indeed, both sides have significant arguments in their favour, as sustainability, on the one hand, will not take place if fundamental action is not taken, though on the other hand, we neither can nor should prescribe specific activities for the individual, bearing in mind the complexity and uncertainty of future developments.

- **Task**: *Discuss in small groups with your peers: what are the arguments for and against instrumental or emancipatory approaches? Where would you position yourself and why?*

In an attempt to reconcile means and ends in education for sustainable development, Vare and Scott (2007) distinguish between ‘ESD-1’, which promotes certain behaviours and ways of thinking, and ‘ESD-2’, which focuses on ‘building capacity to think critically about [and beyond] what experts say and to test sustainable development ideas’, as well as ‘exploring the contradictions inherent in sustainable living’ (Vare and Scott 2007). They argue that while ESD-1 is a necessary form of learning to achieve sustainable development, it is ESD-2 which complements the learning process, as it supports the learner’s capability to analyse, question alternatives and negotiate decisions.

It is the concept of key competencies that has recently gained ground in the debate on intended learning outcomes and brings together both forms of learning. But what exactly do we mean by key competencies? The answer to this question is far from easy. From a rather broad perspective, competencies can be understood as 'a roughly specialised system of abilities, proficiencies or skills that are necessary or sufficient to reach a specific goal' (Weinert 2001: 45). Competencies are developed as a response to complex demands that necessitate the interplay of cognitive, emotional and motivational dispositions (Klieme et al. 2007). The term '*key* competencies' highlights the significance of certain competencies. Key competencies are relevant across different spheres of life and for all individuals (Rychen and Salganik 2003). They do not replace but rather comprise domain-specific competencies, which are necessary for successful action in certain situations and contexts.

If we now go even one step further and ask about key competencies to be able to contribute to a more sustainable future, the literature on education for sustainable development offers a number of frameworks that define such learning objectives. These approaches use a number of different abstract concepts, such as skills, literacy, competencies or capabilities. What they have in common, though, is the goal of enabling people not just to acquire and generate knowledge, but also to reflect on further effects and the complexity of behaviour and decisions in a future-oriented, global perspective of responsibility. They share a broad consensus on the 'key ingredients', they focus on the aspects that are important for future change agents and key actors in different and sustainability-related contexts, and they intend to reconcile instrumental and emancipatory approaches.

It is the work of Wiek et al. (2011) that provides us with insights into what such a set of sustainability-related key competencies might look like, enabling students, especially those of sustainability science, to analyse and solve sustainability problems and thus to create opportunities for sustainability. In a systematic approach, they derived a set of key competencies, specified as sustainability research and problem-solving competence (see Table 27.1).

This set of competencies is based on the insight that sustainability problems have specific characteristics, and therefore, analysing and solving sustainability problems require a particular set of interlinked and interdependent key competencies. As students in sustainability science should be enabled to plan, conduct and engage in sustainability research and problem-solving, it is precisely the interplay of systems thinking, anticipatory, normative, strategic and interpersonal competencies upon which higher education for sustainable development needs to focus.

3 How Can the Development of Competencies Be Supported?

Having defined sustainability-related key competencies as intended learning outcomes in education for sustainable development, the question remains as to how to facilitate the development of such competencies. There are two areas in which

Table 27.1 Sustainability research and problem-solving competencies (Wiek et al. 2011)

1. Systems thinking competence:
The ability to collectively analyse complex systems across different domains and across different scales, thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks
2. Anticipatory competence:
The ability to collectively analyse, evaluate and craft rich 'pictures' of the future related to sustainability issues and sustainability problem-solving frameworks
3. Normative competence:
The ability to collectively map, specify, apply, reconcile and negotiate sustainability values, principles, goals and targets
4. Strategic competence:
The ability to collectively design and implement interventions, transitions and transformative governance strategies towards sustainability
5. Interpersonal competence:
The ability to motivate, enable and facilitate collaborative and participatory sustainability research and problem-solving

competence development takes place that can be distinguished, namely, formal and informal learning.

3.1 Competence Development in Formal Learning Settings

When we focus on competence development in formal education, it is necessary to consider new ways of teaching and learning as key competencies can 'be learnt but hardly be taught' (Weinert 2001). Such an orientation challenges traditional views of the relationship of learning outcomes, topics and teaching and learning methods and comes with various shifts: from teacher to learner-centred pedagogies, from input to output orientation and from a focus on content and topics to a focus on problem-solving and processes. This is based on an understanding of learning as situated and as an active construction, in which the emphasis is not exclusively on knowledge creation, but takes in various forms of experience-oriented and problem-based learning.

There are three key principles by which learning processes for supporting competence development can be characterised (see Fig. 27.1). The first principle is *self-directed learning*, which is based on a view of learning not directly linked to teaching and which emphasises the active development of knowledge rather than its mere transfer. It is an approach 'where learners are motivated to assume personal responsibility and collaborative control of the cognitive (self-monitoring) and contextual (self-management) processes in constructing and confirming meaningful and worthwhile learning outcomes' (Garrison 1997: 18). The central role of the learner is explicitly acknowledged, which also calls for a new role for the teacher, who needs to focus on coaching and moderating the learning processes of the students

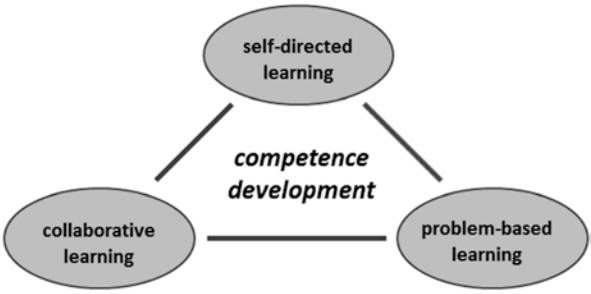

Fig. 27.1 Key principles of learning and competence development

who take ownership of their learning. The aim is then to stimulate learning processes in which students construct their knowledge independently.

Collaborative learning is the second important principle, as the acquisition of competencies is both an individual and a social activity. In collaboration processes, learners not only have to deal with different perspectives but are forced to elaborate and defend their own perspective, which increases their social and discursive abilities. This is of utmost importance for competence development, as it addresses both cognitive and social-affective aspects of learning. Learning is based on shared experiences and jointly accepted learning objectives and happens individually and in the group on the basis of collaborative experiences. Thus, knowledge is seen as the result of shared group processes, and different opinions and approaches are not only tolerated but appreciated and even encouraged.

The third principle, that of *problem-oriented learning*, focuses on complex real-world situations and the development of creative solutions to trigger competence development (Brundiers and Wiek 2013). While traditional learning processes often encounter problems because of their exclusive focus on factual knowledge, which cannot be used for action in specific situations, a problem-oriented approach is especially suited to supporting action-relevant procedural knowledge and skills. Problem-oriented learning provides a motivating context, as students experience authentic situations in which they do not just learn 'dry' theory but tackle the respective issues on their own. It is facilitated by complex 'real-world' problems and different approaches and perspectives. Thus, the first two principles of self-directed learning and collaboration can be seen as preconditions for a problem-oriented approach. See chap. 29 in this book.

While these three key principles provide a strong base for different approaches, it goes without saying that there is no simple formula that fits all contexts and situations. Instead, the successful support of competence development in formal education relies heavily on pedagogical creativity to create learning environments that are supportive, motivating and challenging for students.

- **Task**: *Think about your own experiences as a student in higher education. Where have you experienced learning processes, which relied on the principles outlined above? If this was not (always) the case, how would you picture a really*

supportive learning environment? What change would be needed to offer the best opportunities for competence development?

3.2 Informal Learning and Competence Development

From an educational perspective, formal learning within schools and universities is of primary interest. But if you think of the manifold opportunities in which learning takes place in different environments, formal learning is no longer the only perspective. Students' learning also takes place as informal learning, and it is of great importance that the institutional context is experienced as a learning environment that offers opportunities to engage with sustainability-related issues.

In many case studies, it has been analysed as to how the institution itself can be used as just such an informal learning space. Informal learning that is always self-directed and often appears as incidental and experiential learning contributes to developing competencies, as it is linked to active involvement of the learner and always happens in contexts that are meaningful for that learner. To support such a form of learning, it is important to provide time and space for the form, to examine the environment with regard to learning opportunities and to create an atmosphere of cooperation and confidence in which the learning process can be reflected (Barth et al. 2007).

In the higher education context, it is the metaphor of the 'living lab' that expresses well how sustainability can be dealt with in the campus community and in the wider community of an institution (Brundiers et al. 2010). It refers to the practice of students having to deal with challenges directly connected to their own lifeworld during their learning process, in which solutions are developed and projects are started. Such learning is especially powerful, if links between formal and informal learning are utilised. For students, it is then highly motivating to have manifold opportunities for self-directed learning while support and guidance from lecturers are available.

4 What Can Educational Science Contribute to Sustainability Science?

So far, we have looked at how competence development can be supported in formal and informal learning and thus how education is responding to the challenges that arise from striving for sustainability. But this is only one side of the complex relationship between education and sustainability science. Educational science, in turn, also has much to offer to the transdisciplinary arena of sustainability science. For the ongoing discourse within sustainability science, an educational perspective offers new insights into the understanding of both individual and social transformation processes and broadens the variety of disciplinary contributions. This is even more important when we remember that it is increasingly acknowledged that the

transformation towards a more sustainable future will call on all our resources to learn and adapt. When we look at the strive for sustainability as a shared learning process, insights into how best to support learning processes can and must be added from an educational perspective.

Further Reading

Barth M (2014) Implementing sustainability in higher education: learning in an age of transformation, Routledge studies in sustainable development series. Taylor & Francis, London

Much of what could be only touched upon in this overview is elaborated on in my latest monograph, so I hope you forgive me a bit of self-promoting here

Orr DW (2004) Earth in mind: on education, environment, and the human prospect. Island Press, Washington, DC

David Orr's wonderful book is one of the more elaborate contributions to the debate about what education can or should be. He refers specifically to environmental education, but this, of course, is even more important in education for sustainable development

Rychen DS, Salganik LH (eds) (2001) Defining and selecting key competencies. Hogrefe & Huber Publishers, Seattle

A thorough understanding of key competencies and how to define and select them is provided in this book from Dominique Rychen and Laura Salganik

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability: a reference framework for academic program development. Sustain Sci 6(2):203–218

Arnim Wiek and his colleagues provide us with an overview of how the concept of competencies is used in education for sustainable development and offer a concise concept of sustainability related competencies

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Weinert FE (2001) Concept of competence. In: Rychen DS, Salganik LH (eds) Defining and selecting key competencies. Hogrefe & Huber Publishers, Seattle, pp 45–66

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability: a reference framework for academic program development. Sustain Sci 6(2):203–218