Sustainability Science and Education for Sustainable Development in Universities: A Way for Transition

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Abstract The debate about sustainable development (SD) in higher education institutions has expanded over the past decades. It has been recognized that universities play a pivotal role in promoting sustainability principles, contributing to the paradigm shift toward a more sustainable present and future. Campus sustainability—commonly understood in a broad sense that includes the physical, educational (teaching, curricula, research), and institutional dimensions—is an evolving study field, as indicated by the growing number of articles in academic journals, conferences, awards, and books (like the present one) dedicated to the subject. From the academic point of view, the emergent fields of sustainability science and Education for Sustainable Development (ESD) have advanced the

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efforts of mainstreaming sustainability and implementing concrete practices in universities. But despite some progress and good examples, only a few institutions follow a SD implementation process holistically. A one-sided trend of "going green," driven by market requirements, marketing advantages, and economic benefits, increases the risks of greenwashing. Reductionist models and misconceptions may cause sustainability initiatives to be wrongly reduced to single aspects of SD like environmental initiatives, losing meaning and credibility. This chapter addresses the question of what role the emerging fields of sustainability science and ESD can play within the transition to more sustainable universities. It aims to contribute to a more holistic perception of SD and examines some of the trends being observed in the higher education sector. Universities are challenged to reflect about educational objectives and strategic goals in their sustainability implementation processes, if they aim to educate the academic community beyond eco-efficiency and recycling. ESD and sustainability science are normative academic fields, action-oriented and close to society. Along with universities as democratic institutions, these fields constitute essential vehicles to investigate, test, and develop conditions for truly transformative change.

Keywords Sustainability science · Education for sustainable development · Higher education institutions · Transition · Campus sustainability · Greenwashing

Introduction

Sustainable development (SD) and the question of how to overcome global and local challenges such as climate change, social inequity, poverty, loss of biodiversity, overpopulation, and lack of resources, has been discussed at the highest international political level for over four decades. The concept of SD has become globally accepted as a concept to guide interactions between nature and society in order to master these challenges, calling for a paradigm change at all levels, including education.

Within this debate, universities have been charged with key roles in promoting and implementing SD (UNCED 1992). Many scholars see the impact of universities on SD as vastly greater than any other single sector of society (Cortese 1999, 2003; Orr 2004), because universities educate the next generation of decision-makers, influencers and leaders (ibid., Lozano 2006; Chambers 2009). Due to their high societal impact, universities are seen as multipliers for disseminating SD principles with the ethical obligation to systematically integrate SD into their institutions (UNCED 1992; Cortese 1999; van Weenen 2000; Sharp 2002; Cortese 2003; Hansen and Lehmann 2006). An increasing number of universities have responded, and much progress in the implementation of SD in universities has been achieved.

The emerging fields of sustainability science and Education for Sustainable Development (ESD) can be seen as an evolving scientific foundation for the advancement of sustainability, including the transition to sustainable universities.

This chapter concerns these emerging fields and their role within SD implementation processes in universities. The objective of this chapter is twofold: (i) to offer a literature review with the purpose of sharing some of the most recent advancements and discussions in these emerging scientific fields; (ii) to discuss some trends across the university landscape that are adverse to a holistic sustainability implementation in higher education, posing challenges for sustainability science and ESD in universities. In this way, the authors hope to broaden the overall debate about SD and the visions for a sustainable future.

Sustainability science has emerged over the last decade as a new interdisciplinary field that attempts to conduct problem-driven and action-oriented research on the challenges mentioned above, striving to link knowledge to social actions and creating new visions of natural and social well-being (Miller 2013). ESD, being part of the sustainability discourse and policy-making process since the very beginning, has been influencing the debate on learning objectives, content, pedagogies, and competencies necessary for the paradigm shift to SD.

Both fields, sustainability science and ESD, share some similarities, as they (i) are problem-driven, (ii) employ use-inspired basic research, and (iii) deal with problems of practice and policy (Barth and Michelsen 2013). They can therefore be considered essential for university research on sustainability.

Campus sustainability, commonly understood in a broad sense that includes the physical, educational, and institutional dimensions, is a growing study field, as proven by the increasing number of articles in academic journals (e.g., in the *Journal of Cleaner Production* (Elsevier), *International Journal for Sustainability in Higher Education* (Emerald), *Journal of Education for Sustainable Development* (SAGE), *Sustainability Science* (Springer), *Higher Education Policy* (Palgrave) and others). On the institutional level, many declarations of commitment have been signed (Wright 2002; Leal Filho 2011; Lozano et al. 2013b and the high number of best practice examples and case studies are a sign of the growing importance SD implementation is obtaining (see e.g., the series of the Global University Network of Innovation on social commitment of universities 1–4, GUNI (2012)).

Despite the progress made and some signs of transition in parts of the academic community, there is still a long way to go to mainstream sustainability in higher education, and a paradigm shift from unsustainability to sustainability is still difficult to identify (Wals 2013). Even institutions with many years of experience in the field of campus sustainability are caught in situations that hinder a full sustainability implementation (Escrigas 2012; Raskin 2012; Lozano et al. 2013a). It is still too early to speak of a paradigm shift on a broader scale, since the literature suggests that universities have not yet understood the full scope of sustainability challenges (Tilbury 2012) and might be stuck in traditional academic structures and mechanistic mental models (Lozano et al. 2013b). Furthermore, due to the overuse of terms like SD, sustainability and an increasing trend of "going

green" that reduces sustainability to only its environmental aspects, there is a risk of "greenwashing" and sustainability initiatives losing meaning and credibility, often driven by global market requirements (Schwarzin et al. 2012).

The chapter starts by introducing the theoretical context. A brief summary about the concepts of sustainable development and sustainability is given, in which some common misconceptions are pointed out and differences between strong and weak sustainability are explained. Building on this, a brief literature review about sustainability science and ESD is presented. In the next section, the theoretical context is applied to the question of sustainability implementation in universities. Specific characteristics of the university system and related fields of action for sustainability are noted. Milestones in policy-making for sustainability in higher education are contrasted with practical difficulties encountered in implementing these policies. The section that follows deals with the role of sustainability science and ESD within the transition to sustainable universities. University-specific recent advancements in these fields are outlined and put in contrast to trends in higher education that prevent a holistic implementation of the ideas of sustainability. Trends such as a constantly more economy-driven university deviate higher education from a sustainability-driven process. The authors name these situations "transfer problems" as they stand for the gap between proclamation and practice and as they make the shift from unsustainability to sustainability more difficult. Challenges deriving from these transfer problems are discussed and linked to the role sustainability science and ESD can play in decreasing the gap. The chapter finishes with some concluding remarks about potential future progress for sustainability science and ESD in universities.

Theoretical Context

Debating Sustainable Development and Sustainability

The concepts of sustainable development and sustainability have been discussed broadly in the literature (e.g., Kirkby et al. 1995; Hopwood et al. 2005; Baker 2006; Babbie 2010), and it is useful to briefly recall some of the main aspects of this conceptual, ideological, and terminological debate for the reflections in this chapter.

Usually, the origins of the debate about sustainable development are associated with the publication of "Limits to Growth" by the Club of Rome in 1972 (Meadows et al. 1972) and to the UN conference on the Human Environment, held in Stockholm in the same year, but the origin of the concept itself can be traced back 300 years when Hans Carl von Carlowitz published the first work about sustainable forestry (Saechsische Carlowitz-Gesellschaft 2013), and to T.R. Malthus (1766–1834) who noted the environmental limits to population growth (Mebratu 1998). So, despite the habit of linking the emergence of the sustainability concept to the post-industrial era, it is much older. But there is general agreement among

scholars that the WCED-report *"Our common future"* (World Commission on Environment and Development (WCED) 1987), also known as the Brundtland Report, has mainstreamed the concept and spread the nowadays best known and most often quoted definition for sustainable development: *"SD is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

While this definition establishes links between the social, economic, and environmental dimensions, it is also criticized for its anthropocentric focus and its vagueness (Mebratu 1998; Baker 2006; Lozano 2008; Waas et al. 2011). Some scholars recognize that due to its vague characteristics the concept of SD allows several definitions and interpretations to co-exist (Waas et al. 2011). Others see the possibility of building on a minimal common understanding as a political strategy (Daly 1996). However, an "anything-goes-mentality" (Waas et al. 2011 p. 1638) or a simple "feel-good-sustainability" (Jickling and Wals 2012) only weaken the concept, which is counterproductive to all serious sustainability efforts.

Conceptual analyses of the SD concept look at its historical evolution (Mebratu 1998; Fergus and Rowney 2005a; Waas et al. 2011), as well as at differences in the perceptions, identifying e.g. an institutional, ideological, and academic version (Mebratu 1998). Different models vary in the number of "pillars" or dimensions of SD (Baker 2006; Lozano 2008; Waas et al. 2011). Whereas it had been common to envision at least three pillars of SD—economic, social, and environmental, in recent years it has become normal to add fourth and fifth pillars—institutional and cultural (Waas et al. 2011). SD models help to visualize the complex and dynamic interrelations among these pillars, but are often highly anthropocentric and compartmentalized, lacking conceptual coherence and the dimension of time (Lozano 2008).

Baker (2006) discusses in her ladder of sustainable development (ibid., p.30) four different models of sustainable development—(i) pollution control, (ii) weak SD, (iii) strong SD, and (iv) the ideal model;—and compares, e.g., normative principles, governance, technology, policy integration and tools, and the underlying philosophy of each model, which moves from an anthropocentric to a more and more ecocentric worldview, with correspondingly stronger concepts of SD. *Weak sustainability* stands for a substitutability paradigm, in which natural capital as input for consumer goods is substitutable by man-made capital. The model relies on the assumption that technical progress can overcome any resource constraints (Neumayer 2010). *Strong sustainability* on the contrary seeks to maintain nature's functions intact and builds on the preservation of physical stock and all forms of non-substitutable natural goods (ibid.).

The term *sustainable development* is sometimes applied to economic growth as a development strategy, SD being the process to achieve a "better" type of growth, whereas the term *sustainability* would give more emphasis on the environment and stand for the final goal of humanity being able to live within the environmental limits of the planet (Fergus and Rowney 2005b; Lozano 2008; Waas et al. 2011). However, separating these terms is not a common practice in the literature, so this chapter follows the usual approach of using these terms interchangeably. Furthermore, there exists a consensus about the basic principles that the ideas of SD

and sustainability comprise (UNEP 1992; Baker 2006; Waas et al. 2011): normativity, intra- and intergenerational equity, justice, gender equality and participation. These principles have been endorsed by the Rio Declaration at the UN Earth Summit in 1992 and are usually associated to both terms equally.

Sustainability Science

Sustainability science is a relatively young scientific field, still lacking shared conceptual and theoretical components (Kates et al. 2001; Clark and Dickson 2003), which emerged about two decades ago. At the beginning of 2000, a number of scientists (Kates et al. 2001) agreed on some common approaches for sustainability science: "[To] encompass the interaction of global processes with the ecological and social characteristics of particular places and sectors; integrate the effects of key processes across the full range of scales from local to global; and achieve fundamental advances in our ability to address such issues as the behaviour of complex, self-organizing systems, as well as the responses of the nature-society system of governing to multiple and interacting stresses" (Jaeger 2009, p. 2). In other words, it investigates the complex and dynamic interactions between natural and human systems and how these can be transformed in a sustainable way based on a long-term perspective.

The questions in Table 1 demonstrate the wide range of topics and underline the idea that sustainability science refers to "multiple sciences addressing a common theme—the reconciliation of societies' development goals with the planet's environmental limits over the long term" (Jaeger 2009). The underlying

Table 1 The core questions of sustainability science (Kates et al. 2001)

	Core Questions of Sustainability Science
1	How can the dynamic interactions between nature and society—including lags and inertia—be better incorporated into emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?
2	How are long-term trends in environment and development, including consumption and population, reshaping nature-society interactions in ways relevant to sustainability?
3	What determines the vulnerability or resilience of the nature-society system in particular kinds of places and for particular types of ecosystems and human livelihoods?
4	Can scientifically meaningful 'limits' or boundaries be defined that would provide effective warning of conditions beyond which the nature-society systems incur a significantly increased risk of serious degradation?
5	What systems of incentives structures—including markets, rules, norms, and scientific information—can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?
6	How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?

motivation for this type of research can be described as "neither *basic* nor *applied* research, (…) [but as] *use-inspired basic research*" (Clark 2007 p. 1737).

Since sustainability science does not have a common definition, scholars usually refer to its main characteristics or set of principles, which are (i) its transdisciplinarity, (ii) the providing of an integrated analysis, and (iii) its direction toward action (Kates et al. 2001; Rapport 2007; Kauffman 2009; Lang et al. 2012).

Sustainability science above all means to bridge the gap between science and society and to link knowledge to action for sustainability (Wiek et al. 2012). These ideas embrace the principles of ESD, an emerging field within educational science with strong ties to sustainability science.

Education for Sustainable Development

> *"Education either functions as an instrument which is used to facilitate integration of the younger generation into the logic of the present system and bring about conformity or it becomes the practice of freedom, the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world."*
>
> *Paulo Freire (1972)*

The debate about sustainable development has also initiated the debate about an educational concept that would help to achieve the goals of sustainability: ESD. It has been a field for international educational policy-making since the beginning of the SD debate. The ESD concept started being institutionalized in 1992 with the international recognition of Agenda 21 and its specific chapter 36 about education at the UN Earth Summit in Rio de Janeiro (UNCED 1992). The UNESCO was assigned to be the task manager of the implementation of Agenda 21's chapter 36, and ESD received growing attention worldwide. Further milestones were the UNESCO report *"Education for a Sustainable Future"* (UNESCO 1997b), in which the necessity of a reorientation of education in all sectors and the key principles of ESD are stressed, and the launch of the *UN Decade on Education for Sustainable Development* (2005–2014) that stimulated numerous projects on all educational levels. The *"World Conference on ESD - Moving into the Second Half of a UN Decade*" (Bonn, 2009) gave opportunity for reflections on achievements and put a new focus on monitoring and assessment, leading to ESD evaluation reports of several experts (Tilbury 2011; Wals and Nolan 2012).

The educational concept of ESD refers to all educational levels, from kindergarten to primary, secondary, and tertiary education until life long learning, and consists of different learning objectives, content foci, and pedagogical approaches. Even though having clear links to environmental education, ESD goes much beyond this and seeks to:

- Promote and improve the quality of a lifelong education that is directed to the acquisition of knowledge, skills and values necessary for citizens being able to improve their quality of life

- Reorient the curricula (rethinking and reforming education)
- Raise public awareness for the concept of SD
- Train the workforce for a better understanding of ESD and how to integrate it in the curriculum.

(Læssøe et al. 2009; Wals 2009).

Reflecting the difficulty in defining sustainable development, ESD also has no single, uncontested definition, and often terms such as *Education for Sustainability (EfS)* or *Sustainability Education (SE)* are used interchangeably. Other terms used less frequently are: Earth Education; Environmental and Developmental Education; Environmental Education for Sustainability; Education for a Sustainable Future; Education as Sustainability; and Sustainable Development Education (Leal Filho et al. 2009).

There is a divergent debate about the meaning and objectives of ESD, and McKeown et al. (2006), p. 9 link it to the challenge of envisioning a sustainable world and how humanity can achieve it: "(…) while we have difficulty envisioning a sustainable world, we have no difficulty identifying what is unsustainable in our societies," and list several problems of "un-sustainability," like inefficient use of energy, lack of water conservation, increased pollution, abuses of human rights, overuse of personal transportation, consumerism, etc. (ibid.). The authors compare the lack of a definition for ESD to the concepts of justice and democracy, which are "great concepts," but approached differently depending on worldviews and cultures. As an important step of differentiation, scholars distinguish between (a) *education about sustainable development* and (b) *education for sustainable development*. Whereas the first may refer mainly to knowledge transfer about SD, transmitting facts about sustainability concepts without challenging existing assumptions, the second underlines the perception of a learning process, focussing more on a transformative approach to education (McKeown et al. 2006; Barth and Michelsen 2013). This focus is also set in the definition for ESD by UNESCO:

> *"Education for Sustainable Development (ESD) is a learning process (or approach to teaching) based on the ideals and principles that underlie sustainability and is concerned with all levels and types of learning to provide quality education and foster sustainable human development—learning to know, learning to be, learning to live together, learning to do and learning to transform oneself and society"* (UNESCO 2011).

This learning process can, however, have different objectives, and Læssøe et al. (2009) argue in their cross-national study that there are two distinct approaches, directed to different learning outcomes (Fig. 1):

Whereas the empowerment perspective focuses on enabling students to become independent critical thinkers, the behavior modification perspective strives for changes in habits. Vare et al. (2007, pp. 193–194) went in their analysis a little further and differentiate between ESD 1 and ESD 2: the first type comprises an approach of "promoting/facilitating changes in what we do" as well as

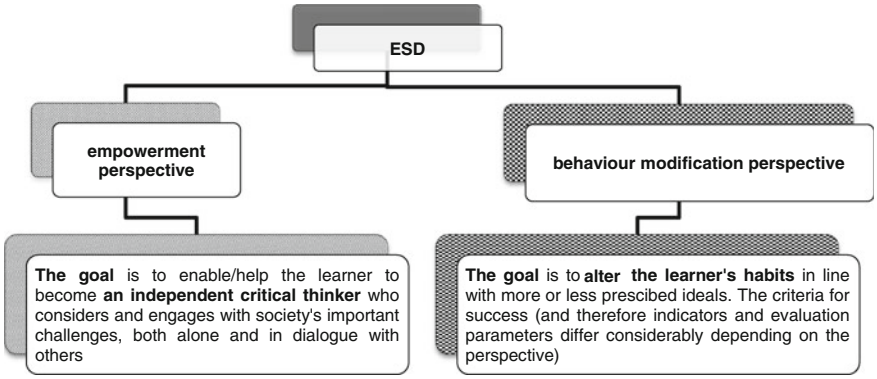

Fig. 1 ESD from the empowerment and the behavior modification perspective (based on Læssøe et al. (2009))

"promoting (…) behaviors and ways of thinking," which the authors label as "Education *for* Sustainable Development." The second type refers to an approach of "building capacity to think critically (…) and exploring the contradictions inherent in sustainable living" (p. 193–194), calling it "Education *as* Sustainable Development" and underlining the overall process-oriented attitude of any way of learning. The authors regard both types as complementary (the "yin-yang of ESD," p.195), but stress the importance of ESD 2 because "our long-term future will depend less on compliance in being trained to do the right thing now, and more on our capability to analyse, to question alternatives and to negotiate our decisions" (ibid., p. 194), as future scenarios are uncertain and request overall being able to approach new challenges systemically. In this context, Barth et al. (2013), p. 107 underline the normativity of the educational concept of ESD that lies "between the two poles of indoctrination and value-relativism" (p. 107): On the one hand, using education for political and social goals is considered inappropriate, and on the other hand the nature of education is based on human values, history, and changes in power relationships and so can never be value-neutral. ESD pedagogies should therefore foster the capacity of critical reflection. These pedagogies are often rooted in existing educational concepts like problem-based learning, social learning, situated learning, social-constructivist approaches to learning (e.g. discovery learning, participatory learning), system-thinking-based learning, among others (Steiner and Posch 2006; Wals and Nolan 2012; for an overview see Barth and Michelsen 2013). By linking these learning approaches to challenges related to sustainability, e.g. complexity, uncertainty, and interdisciplinarity, the ESD concept becomes unique (Barth and Michelsen 2013).

From Theory to Practice: Universities Implementing Sustainability

The University System and Fields of Action for Sustainability

Cortese (2003) identifies four dimensions of a university system: *Education*, *Research*, *University Operations* and *External Community*, which often have been seen as discrete, based on hierarchical and competitive structures. Lozano (2006) adds a fifth dimension of *Assessment and Reporting*. These dimensions should be considered as interconnected and dealt with in a comprehensive, dynamic and horizontal manner (ibid.), since they are crucial for implementing sustainable development in a holistic way. Strategies that are geared to sustainable universities should move beyond eco-efficiency (Shriberg 2002), as there is still an emphasis on the environmental issues and less attention paid to nonmaterialistic aspects of sustainability related to social, cultural and ethical questions. However, progress has been made in curriculum greening (Lidgren et al. 2006), campus operations (e.g., environmental management systems and their educational dimension) (Disterheft et al. 2012), system transition approaches involving large groups of stakeholders (Ferrer-Balas et al. 2009), outreach programs (Johnson Butterfield and Soska 2005) and on assessment and reporting (Lozano 2011). There are also specific conferences with a focus on SD implementation in universities (like the conferences of the Global University Network for Innovation (GUNI), of the Association for the Advancement of Sustainability in Higher Education (AASHE), the Environmental Management for Sustainability in Universities (EMSU) conference and the World Symposium Sustainable Development in Universities (WSSD-U)) as well as sustainability assessment tools (e.g., AISHE, GASU, STAUNCH among others, see Disterheft et al. (2013) for an overview), rating systems (e.g., STARS, Green League) and excellence awards (e.g., Sustainable Campus Excellence Awards) or certifications.

Some Milestones in Policy-Making for Sustainability in Higher Education

At the macro- and meso-level, there have been developed and endorsed more than 20 declarations and policy documents in which higher education institutions declare their commitment to SD (Wright 2002; Leal Filho 2011; Tilbury 2012; Lozano et al. 2013b). All of them are based on a moral obligation toward promoting and contributing to sustainable development within universities: “Perhaps the unifying theme among all declarations and policies is the ethical and moral responsibility of universities to be leaders in promoting sustainability” (Wright 2002).

Wright (ibid.) and Lozano et al. (2013b) examined in detail declarations up to 1997 and 2009, respectively. As a matter of completeness, the list was updated to

the present by consulting further literature sources and conducting an internet search (Table 2).

In general, these declarations can be seen as landmarks, and if properly implemented they can contribute to facilitating change and integrating sustainable development into the universities' landscape. Nevertheless, Wright warns that without an implementation plan these policies remain just a statement of intent and run the risk of serving only to "greenwash" the institutions' image (Wright 2002; 2006). In preparation for the Rio + 20 conference in June 2012, Leal Filho (2012) gave a damning appraisal of these declarations: "Except for the Ubuntu Declaration, which has been pursued by a number of organizations since Johannesburg, the majority of the other declarations, agreements and action plans have one thing in common: they have never been fully implemented." Bekessy et al. (2007) see the lack of accountability of universities as the main problem. In their analysis of the Australian RMIT University's 12-year engagement with sustainability they conclude (ibid., p. 314): "(…) neither non-binding international declarations nor individuals or small groups are the answer to lasting institutional transformation. (…) The positive publicity that universities receive from signing declarations and releasing policy precedes putting them into practice, and it seems that there is little or no motivation to deliver on commitments, or public accountability for failing to deliver. Failure to implement rhetoric is classic greenwash and sends a message to other institutions, companies, governments, and society as a whole that universities do not value sustainability, and are unable to implement it." Christensen et al. (2008) analyzed official university documents of the University of Aalborg (Denmark) from 1990 to 2007, assessing the gap between preaching and practice. The authors ask "How to teach sustainability without practicing it?" (ibid., p. 16) and draw the conclusions that "good intentions are certainly not enough to create a vibrant and engaging working commitment that will make sustainable university practices live on for years" (ibid., p. 18). These examples show that the institutional debate about SD is not finished after the first steps of SD implementation have been undertaken, and actually call for continuous revision and new reengagement. Sustainability science and ESD can contribute systematically to reviewing sustainability implementation in higher education and promoting stronger commitment, as will be discussed in the next section.

The Role of Sustainability Science and ESD Within the Transition to Sustainable Universities

Background

It has been demonstrated above that sustainability science comprises a broad set of areas and topics, aiming to create knowledge that fosters new approaches in addressing the complex sustainability challenges of our world today. ESD is the

Table 2 Chronology of some declarations related to sustainability in higher education adapted and expanded from Wright (2002), Leal Filho (2011), Tilbury (2012) and Lozano et al. (2013b)

Years	Declaration
1972	The Stockholm Declaration On The Human Environment (UNEP 1972)
1977	Tbilisi Declaration (UNESCO 1977)(UNESCO 1977)
1988	The Magna Charta of European Universities (European University Association 1988) (European University Association 1988)
1990	University Presidents for a Sustainable Future: The Talloires Declaration (ULSF 2008)
1991	The Halifax Declaration (International Institute for Sustainable Development 1996)
1992	Agenda 21 Report of the United Nations Conference on Environment and Development—Chap. 36: Promoting Education, Public Awareness and Training (UNCED 1992)
1993	Ninth International Association of Universities Round Table: The Kyoto Declaration (Wright 2002)
1993	Association of Commonwealth Universities' Fifteenth Quinquennial Conference: Swansea Declaration (Wright 2002)
1994	CRE Copernicus Charter (COPERNICUS 1994)
1997	International Conference on Environment and Society—Education and Public Awareness for Sustainability: Declaration of Thessaloniki (UNESCO 1997a)
1998	World Declaration on Higher Education for the twenty-first century: Vision and Action (UNESCO 1998)
2000	Earth Charter *(directed to all education areas, not higher education-specific)* (Earth Charter Initiative 2010)
2001	Lueneburg Declaration (UNESCO 2001)
2002	Ubuntu Declaration (United Nations 2002)
2005-2014	The UN Decade Education for Sustainable Development (UNESCO 2010)
2005	Graz Declaration on Committing Universities to Sustainable Development (Leal Filho 2011)
2006	Declaration on the Responsibility of Higher Education for a Democratic Culture—Citizenship, Human Rights and Sustainability (Council of Europe 2006)
2008	G8 University Summit Sapporo Sustainability Declaration (Leal Filho 2011)
2009	Abuja Declaration on Sustainable Development in Africa (Lozano et al. 2013b)
2009	Tokyo Declaration of HOPE (directed to all education areas, not higher education-specific) (ACCU 2009)
2009	Turin Declaration on Education and Research for Sustainable and Responsible Development Italy (Tilbury 2012; Lozano et al. 2013b)
2009	World Conference on Higher Education (UNESCO) (Tilbury 2012)
2010	G8 University Summit: Statement of Action (Leal Filho 2011)
2011	Copernicus Charta 2.0. (Copernicus Alliance 2012a)
2012	People's Sustainability Treaty on Higher Education (Copernicus Alliance 2012b)
2012	UN Higher Education Sustainability Initiative within Rio + 20 (United Nations 2012)

educational concept to complement and stimulate these approaches. Both fields are not higher education-specific, but the growing research on sustainability in higher education can be linked closely to these emerging sciences (Wiek et al. 2011; Barth and Michelsen 2013). However, these links might not be clear to everybody.

There are some scholars who see the necessity to study further how university research for SD relates to other sustainability research fields, for example sustainability science (Waas et al. 2010). They define university research for sustainable development as "*all research conducted within the institutional context of a university that contributes to sustainable development*" (ibid.).

In this section, this type of research is embedded in the broader fields of sustainability science and ESD, as suggested in a great part of the literature. With a focus on higher education, it discusses some of the most recent advancements as well as transfer problems and challenges on the practical level.

Advancements

Interesting research is going on in these emerging fields: several research agendas and evolving frameworks have been developed for sustainability science in general (Jerneck et al. 2011; Schoolman et al. 2012; Miller 2013), and for higher education in particular (Stephens and Graham 2010; Waas et al. 2010; Yarime et al. 2012). Some scholars ask whether the concept of SD influences educational science with regard to teaching and learning development as an "outside-in approach" (Barth and Michelsen 2013) or whether educational science contributes to sustainability science as an "inside-out approach" (ibid.). Similarly, Lozano et al. (2013a) ask whether universities are taking the lead in the advancement of SD mental models or merely reacting to the stimuli from society.

Tilbury (2012) distinguishes shifts in the research for sustainability in higher education over the past 10 years toward more inclusiveness and higher social impact (Table 3).

Bibliometric studies on ESD research in universities (Barth and Rieckmann 2013; Wals 2013) have shown that environmental sustainability has been the dominating research focus—e.g., environmental management, university greening and reducing the university's ecological footprint—, but a recent shift in the

Table 3 Key movements in research for sustainability in higher education over the last ten years (~ 2000–2010) (Tilbury, 2012, p. 21)

Shifts from	To be more inclusive of
Research that is disciplined focused	Research that is inter- and multidisciplinary
Research that has academic impacts	Research that has social impact
Research that informs	Research that transforms
Research on technological and behavior change	Research that focuses on social and structural change
Research as expert	Research as partner
Research on people	Research with people

research focus can be confirmed: articles on pedagogy, learning, community outreach, and partnerships are appearing more frequently (Wals 2013). However, these analyses have also shown that the majority of publications are descriptive case-study articles, with "minimal cohesion and some degree of repetition and redundancy" (Stephens and Graham 2010, p. 611) and still lack a stronger theory development (ibid.).

Among these topics, the debate about competencies has gained particular visibility (de Haan 2006; Posch and Steiner 2006; Barth et al. 2007; Mochizuki and Fadeeva 2010; Parker 2010; Wals 2010; Wiek et al. 2011; Rieckmann 2012). Unfortunately, the terminology used in this debate is not always clear. Although scholars distinguish between *competencies for sustainability* and *competencies for ESD*, either of these terms may have different understandings: Wals (2010, 2013) understands *sustainability competencies* as those abilities that learners should develop when they engage in ESD, whereas *ESD competencies* refer to the abilities of the person who facilitates ESD in transmitting SD competencies to the learner. On the contrary, Wiek et al. (2011) distinguish between *key competencies in sustainability* and *basic competencies:* the first refer to competencies transmitted in specific higher education programs and courses in sustainability, namely (i) *system-thinking competence*, (ii) *anticipatory competence*, (iii) *normative competence*, (iv) *strategic competence*, and (v) *interpersonal competence*. Basic competencies, such as *critical thinking* and *communication*, are considered equally important, but taught in other contexts not necessarily sustainability-specific. Riekmann (2012) arrives at similar terms but does not differentiate between sustainability-specific and nonsustainability-specific competencies. He considers them all equally relevant for future-oriented learning and builds on the ideas about *Gestaltungskompetenz* (de Haan 2006) and transformative social learning (Palmer et al. 2010; Wals 2010; Brundiers and Wiek 2011; Schwarzin et al. 2012). Gestaltungskompetenz can be translated by "shaping competences" (Baer et al. 2012) and is understood as a forward-looking ability to "modify and model the future of the societies that [one] live [s] in, participating actively in the spirit of sustainable development" (2006 p.22). As key competences for ESD, de Haan (2006) identifies (i) competences in foresighted thinking; (ii) competence in interdisciplinary work; (iii) competence in cosmopolitan perception; cross-cultural understanding and cooperation; (iv) participatory skills; (v) competence in planning and implementation; (vi) capacity for empathy, compassion and solidarity; (vii) competence in self-motivation and in motivating others; and (viii) competence in distanced reflection on individual and cultural models.

These approaches can be grouped under the empowerment-perspective as outlined earlier in this chapter and may indeed be a sign of shift toward a research that strives for transformation rather than information and for social and structural change, rather than technological and behavioral change (Table 3).

Some authors alert that the competence approach is too narrow when related only to workplace performance without being also directed toward the goals of sustainability (Mochizuki and Fadeeva 2010). Tilbury (2012, p. 24) argues that "teachers, architects, accounts, doctors and business managers are still being schooled into social assumptions and practices that serve to exploit people and planet." The development of specific courses and programs on sustainability, usually called a *built-on approach*, would only improve the sustainability literacy of a self-selected group who wish to follow a career in this field (ibid.). Instead, a *built-in approach* is needed that integrates sustainability in existing study and research (Wals 2013). For Wals (ibid.), the concept of SD is still understood in a too limited manner, as "sustainability (…) remains still largely external to the student, academic faculty member, and administrator within higher education." Therefore, the reorientation of teaching, the renewal of the curricula and learning methods, and the offering of learning opportunities in higher education for staff members are considered to be key elements in the transition toward sustainability and more sustainable institutions. One pillar in this discussion is training the workforce (Zilahy and Huisingh 2009; Barth and Rieckmann 2012). With regard to academic staff development in higher education institutions, there are already promising studies which describe specific programs for teaching staff members in universities. These programs show diverse opportunities for new learning and teaching approaches that can lead to a deeper implementation of ESD in higher education institutions (Huisingh and Mebratu 2000; Barth and Rieckmann 2012).

Transfer Problems

Despite some progress there appear to be several transfer problems that make a so often proclaimed paradigm shift to more sustainability difficult. Scientists would agree that the state of the planet has worsened in the last 20 years, in environmental terms, but also in social terms regarding issues of inequity, marginalization and poverty (Jickling and Wals 2012). Universities are caught in a crossfire of influences, and so are sustainability science and ESD implementation processes. The advancements reported above contrast to other trends that can be observed in higher education.

From a macro level perspective:

- Universities orient their activities to more economic-driven directions, with a strong belief in the power of market mechanisms and competition (Raskin 2012; Schwarzin et al. 2012), based on a business-as-usual approach instead of sustainability principles. A new model of the *entrepreneurial university* can be identified that "utilizes relations with industry and government in order to

contribute to an innovation-driven regional or national economic growth strategy"(Yarime et al. 2012 p. 102). Other signs are technology parks, academic inventions (e.g. via spin-off firms or ventures), collaborative and commissioned research, consulting (ibid.). Quality assessment based on number of publications and student numbers decisive for the university ranking have become primary concerns of university leaders (O'Brien et al. 2013).

- Privatization of public education and increase of private universities as a response to the "knowledge economy." The UNESCO report *Trends in Global Higher Education* (Altbach et al. 2009, p. 69 et seq.) discusses the problematic issues of (in-)equity in accessing higher education and describes the trend of the marketization of education with rising tuition fees and decreasing scholarships as one of the biggest challenges for a sustainable higher education sector.

From a meso- and micro level perspective:

- Universities remain traditional and follow old mechanistic mental models (e.g. Newtonian and Cartesian paradigms) (Lozano et al. 2013a) with strong disciplinary structures that hinder inter- and transdisciplinary approaches.
- Even though a holistic approach in sustainability is often proclaimed, a narrow perception of sustainability prevails, focusing on the environmental and economic aspects of SD (Leal Filho 2009; Global University Network for Innovation (GUNI) 2012). As a consequence, sustainability initiatives at the campus run the risk of serving greenwashing purposes.
- According to the literature, some of the barriers within campus sustainability implementation include: (a) misconceptions of the concept of SD (e.g., sustainability is too broad, too abstract, too theoretical, too recent), (b) conservatism or unwillingness to change, (c) discipline-restricted organizational structures, (d) procrastination, (e) power-related aspects, (f) lack of support, (g) lack of relevant and complete SD information, (h) lack of SD awareness, (i) over-crowded curricula, and (j) fear of extra work (Leal Filho 2000; Dahle and Neumayer 2001; Lozano 2006; Leal Filho 2011).

Challenges

As a response to these problems, what can the role of sustainability science and ESD in higher education be? How can we achieve more effective knowledge transfer and broader engagement that indeed bridges the gap between science and society? Some reflections are outlined below:

- Sustainability science and ESD are value-driven, following normativity principles of sustainability, which put them in a special position, as their research approaches are not neutral. The economy-oriented trend in universities, which becomes especially problematic when the idea of contributing to *society* becomes synonymous with contributing to the *economy* (Yarime et al. 2012), is entering as well the sustainability discourse, e.g., through the concept of a Green

Economy.[1] Yarime et al. (2012) alert to several disadvantages for universities following this trend: (i) the entrepreneurial model and conventional technology transfer practices are not necessarily appropriate for promoting larger socio-technical innovation; (ii) this model is not focused on the sustainable development of local and regional communities; (iii) it follows a paradigm that incentivizes business-as-usual economic growth and does not compulsorily address pressing social or environmental issues; and (iv) negative effects of corporate-like competition may push aside the academic tradition of open sharing and collaboration. Here, a stronger debate about the concept of SD is required that puts into discussion strong vs. weak sustainability and stimulates visions of a more sustainable present and future encouraging alternatives to the business-as-usual model. From an educational point of view, the observed managerial approach favors educating people *to adapt to change* rather than building their capacity *to shape and create change* (O'Brien et al. 2013). Here, the already mentioned reorientation of curricula and learning needs to be led by ESD scholars.

- Social sustainability—which, e.g., focuses on equity of access to key services, including education, and on community responsibility in a long-term, intergenerational perspective—relates to institutional changes in the HEI governance model and changes in the curriculum, but these appear to be less central to the sustainability research agenda in universities. The most innovative and eco-efficient university would fail the sustainability principles of social justice if it addresses only a small group of elite students with sufficient financial capacities to attend their programs. Noam Chomsky's recent speech on "Public Education and The Common Good" (Cohen 2013) is a valuable source for rethinking financing higher education. These problems are still lacking in the research agenda for sustainability in higher education.
- Ranking/assessment tools and evaluation procedures focus on economic numbers instead of sustainably oriented governance models and future-oriented curricula/learning and teaching approaches. Here, sustainability research in universities can offer alternatives (see e.g., Lukman et al. (2010)). Sustainability assessment in higher education has become a growing study field (see "The University System and Fields of Action for Sustainability" for sustainability assessment tools applied in universities). However, it remains a challenge that assessment processes embrace sustainability holistically (Wals 2013), and more research and improvement is needed. According to Jones (2012), for example,

[1] The concept of green economy (GE) emerged primarily outside the context of the SD framework and is not built on sustainability principles (Baer et al. 2012). The Rio +20 summit in 2012 can be seen as an attempt to introduce the GE concept into the SD debate, and it was strongly promoted by some global players, whilst at the same time being received sceptically and rejected by others (Brand 2012; Bullard and Mueller 2012). GE is based on pillars like the environmental technology sector and green jobs, and strives for economic measurement beyond GDP. It still adheres basically to the concept of economic growth as a strategy for human well-being while reducing environmental risks and ecological shortages (Jones 2012).

> "ticking simple check boxes [in sustainability assessment procedures] does not encourage rethinking current doctrines of progress and modernity in order to develop new visions of the world," nor do these procedures foster a better human-nature relationship, but merely follow "aspects of managerial efficiency and the logic of markets." Here again, sustainability science should ask universities to reflect on what type of development they wish to pursue and which underlying educational objectives are at stake. The scope of universities' holistic sustainability understanding determines what categories and indicators they will consider when making sustainability assessments.

In order for the research shift noted in Table 3 to gain more momentum, other challenges such as the fragmentation of disciplines (Waas et al. 2010) and discipline-specific procedures of quality assessment and research funding need to be addressed (Barth and Michelsen 2013). However, there is a deep paradox in universities as institutions: Though directed toward teaching, they themselves learn very slowly and thereby delay changes from taking place (Stephens and Graham 2010).

Summing up, universities face tensions from strong economic and market forces, on national and global scales, and it is doubtful that any university can escape these influences. This discourse necessarily turns again to perceptions of sustainable development, to underlying divergent worldviews and to the question of whether the main objective is to follow a "strong" or "weak" sustainable development paradigm (Baker 2006; Neumayer 2010). Waas et al. (2010) consider it "imperative that one distinguishes between trivial or less useful conceptualizations and useful ones." Sustainability science and ESD are the scientific platforms to inform this choice.

Furthermore, they advance this ongoing debate by creating settings that permit the academic community to develop the new competencies, visions, and mental models necessary for a paradigm change. Such new settings are of central importance for the upcoming generation of scientists to experience inter- and transdisciplinary research approaches.

Jackson (2009) suggests a new paradigm without economic growth in which people "flourish as human beings—within the ecological limits of a finite planet" (p.16) and perceives as the most urgent task for society to create the conditions under which this flourishing is possible. The concept of degrowth emerged as an alternative to the neoliberal concept of infinite economic growth and has lately gained increasing attention in social media and research activities (Jackson 2009; Schneider et al. 2010; Research & Degrowth 2013b; The New York Times' Room for Debate 2013). This concept strives for downscaling of production and consumption, and at the same time, for increasing human well-being and enhancement of the ecological conditions, as well as equity on the planet. In order to achieve these goals, degrowth aims to develop strategies that help societies "to live within their ecological means, with open, localized economies and resources more

equally distributed through new forms of democratic institutions" (Research & Degrowth 2013a). These strategies aim to substitute efficiency with sufficiency and promote innovation that "will no longer focus on technology for technology's sake but will concentrate on new social and technical arrangements that will enable us to live convivially and frugally" (ibid.). ESD and sustainability science as normative academic fields, action-oriented and close to society, together with universities as experimental areas, could include these strategies in their research agendas.

Concluding Remarks

The fields of ESD and sustainability science form the scientific basis for research on sustainability in higher education and can be seen as a way for transition.

Despite some progress, for example in shifting sustainability research in universities closer to society and following more transformative approaches, especially with regard to competencies development, both fields are still a niche in the research landscape. However, they play a crucial role in opening up university research to more inter- and transdisciplinarity and to develop more appropriate approaches to tackle the complex sustainability challenges our world is facing.

As old mental models and reductionist perceptions of SD still prevail, these fields are of utmost importance to correct misconceptions and to follow a strong sustainability paradigm that opposes the neoliberal trends taking place globally in higher education. By providing new platforms and approaches, sustainability science and ESD foster a more open dialog on visions and interpretations for SD and the development of new mental models. In this dialog, more inter- and transdisciplinarity as well as critical thinking, system-thinking, and anticipatory thinking are vital for the transition to sustainable universities and for enhancing the SD debate.

It is desirable that more disciplines than those related to environmental and educational science join this dialog, like for example humanities, to enrich, diversify, and enlarge the forms of communication that are urgently needed in the overall SD discourse.

ESD and sustainability science, along with universities as democratic institutions, constitute essential vehicles to investigate, test, and develop conditions for truly transformative change.

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