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EDUCATION FOR ALL UDINE

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Table 2
Education and sustainability

Education for sustainability
Practices, tools and solutions

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Università di Siena

Position Paper

Education for sustainability
Practices, tools and solutions[1*]

1. Introduction

In September 2015, during the United Nations General Assembly, a new global development agenda was adopted by all the member states in order to define development priorities up to 2030 in line with the Millennium Development Goals (MDGs) and Education for All (EFA), which expired in 2015. The 2030 Agenda for Sustainable Development includes a set of 17 Sustainable Development Goals (SDGs), which are reference objectives for post-2015 international development. Within this new international framework, education was identified as a standalone goal (SDG4) since it has a pivotal role as a key enabler of sustainable development.

Education, indeed, is a strategic resource for building resilient and sustainable societies (UNESCO, 2013), because it plays a central role in changing the lifestyle and minds of people in relation to specific themes. It may lead to the right type of actions, attitudes and behaviour, creating conditions for active and aware citizenship (from an early age) that will lead to sustainable and inclusive growth (UNESCO 2012). Furthermore, education is an essential tool for contrasting negative phenomena such as poverty, child mortality, unemployment, low education levels and lack of opportunities for the younger generation, and can also help to reduce the fatalities linked to hydro-geological risks. It can transform agriculture and increase food production and its fairer distribution in the world (UNESCO, 2016a). Therefore, quality teaching is essential to shape common values and a respect for these and to improve social inclusion, with the commitment to "leave no one behind" (H4All). This applies particularly to vulnerable groups, such as women, people with disabilities, ethnic and linguistic minorities, refugees, etc. (*Ibidem*).

Certainly, education can have a role which is not always positive for sustainability. It can "contribute to unsustainable practices, including overconsumption of resources, and exacerbate the loss of relatively sustainable indigenous knowledge and ways of living. Education may need to be shaped and transformed to ensure its impact is positive" (*Ibidem*, p. 11). For these reasons, it is necessary to analyse in detail what kind of education we need to ensure its impact is positive: i.e., the best practices, tools and solutions that are able to foster sustainable development at a global level. In the last decades, G7 ministers, international organizations (OECD, UNESCO, etc.), and different stakeholders have collectively defined and improved guidelines and principles on which a positive education ought to be based, through several reports specifically focused on its capacity to foster development which is capable of balancing economic, social and environmental sustainability factors (see, in particular, 2015 Incheon Declaration and 2016 Kurashiki Declaration).

After analysing the background to and actors in Education for Sustainable Development, this paper aims to analyse the inclusion of sustainability in HE curricula and classrooms. It identifies trends, methodologies and learning processes in order to better understand the present scenario and suggest specific policies for its improvement. The paper highlights evidence, practices and policies by investigating:

1. recent literature on these topics;

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2. characteristics of teaching sustainability in the traditional face-to-face classroom environment and in an open online environment, analysing in particular MOOCs (Massive Online Open Courses) across different massive open online learning platforms.

To achieve these findings, the University of Siena has developed the survey "The role of Higher Education in fostering sustainable development" in four languages (English, French, Spanish and Italian) to collect as much information as possible on the ongoing educational activities in Education and Sustainability worldwide[2], and has structured a digital repository of MOOCs called *ReSi* (Repository on Sustainable Issues).

After drawing attention to the background and actors of ESD (§2), the paper examines the inclusion of sustainability in HE teaching activities (§3) and the role of the MOOCs in determining new learning possibilities (§4). Finally, the paper identifies some current barriers to ESD and suggests specific action for the improvement of sustainability in HE at the same time (§5). Furthermore, Annex A (§6) presents the SDG4-Education 2030 Agenda and, finally, Annex B provides a summary table on the last *Unesco policy recommendations* on SDG4 (UNESCO, 2016a).

2. Background to and actors in Education for Sustainable Development

Nowadays, there is growing international recognition of ESD as an integral element of sustainable development. However, ESD, in the form of higher education (HE), has a long history as an international priority (fig. 1). In 1987 the Brundtland Report by the World Commission on Environment and Development mentioned 'sustainability education' for the first time and in 1992 the concept was taken up and stressed in Agenda 21 from the Earth Summit of the United Nations Conference on Environment and Development (Zehui, et al., 2015). In 2013, during the 37th session of the UNESCO General Conference, the *Global Action Program* (GAP) on Sustainable Development Education was approved and, in 2014, UNESCO[3] published the 'Roadmap for Implementing the Global Action Programme on Education for Sustainable Development' to mobilise the community of stakeholders in Education for Sustainable Development towards urgent action to further strengthen it and scale it up.
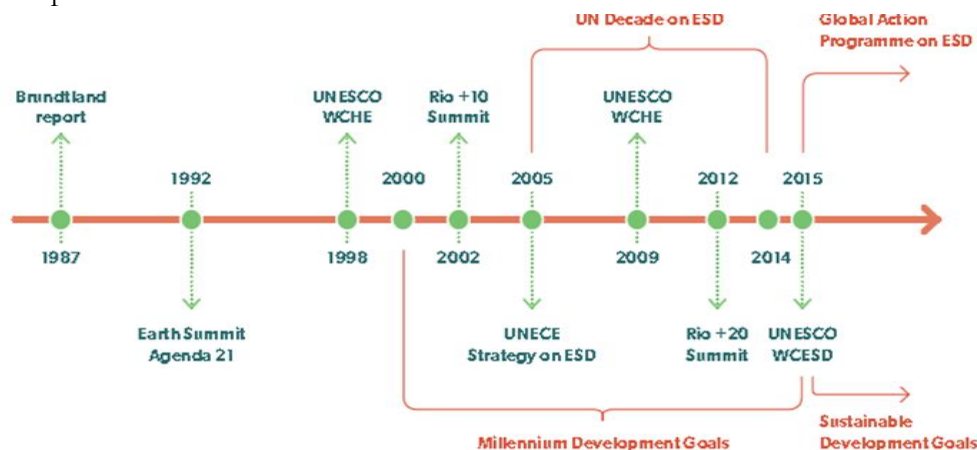

Fig. 1. Timeline of the progress of ESD global efforts with an impact on HE in the UNECE region.
Source: UE4SD (2015, p. 22)

2   The survey is open to all institutions (universities, research institutions, NGOs, etc.) that are involved in education for sustainability and it has been spreading with the support of several international networks (SDSN, EUA, WEEC).
3   UNESCO also monitored and evaluated progress during the UN Decade of Education for Sustainable Development (DESD, 2005-2014), publishing three reports in 2009, 2012 and 2014.

The GAP combines a two-fold approach to scale up ESD action: (a) integrating sustainable development into education and (b) integrating education into sustainable development (UNESCO, 2014).

Sustainable development and education for sustainable development are therefore two sides of the same coin[4]. For these reasons, education is one of the top priorities of the international political agenda on Sustainability. The *Kurashiki Declaration*, which was signed during the G7 Kurashiki Education Ministers' Meeting on 14 May 2016 in Japan, emphasizes this idea, placing strong focus on education as a "basic human right [...] essential for the development of peaceful, prosperous and sustainable societies"(Kurashiki Declaration, p. 3).

The growing centrality of education in sustainable development is connected to the increase in the number of courses and books produced on the subject. In this regard, the UE4SD (University Educators for Sustainable Development) mapped the National Sustainable Education Development policies adopted by the 32 member states in Europe in 2014. The Final Report shows that 85% of countries (27 out of 32) referred to the adoption of ESD strategies in HE on a national and/or regional scale (UE4SD, 2015). Also an increasing number of the workplace-based programmes called TVET (*Technical Vocational Education and Training*) include ESD in their programmes. The GEM Report from 12 countries showed that about 20% of youth had participated in TVET (UNESCO, 2016a). These courses are directly linked to the labour market and employer requirements, and they generally involve work placements as part of their programmes. Green jobs have a high projected level of growth between now and 2024, especially in lower income countries (*Ibidem*). This is determined by two processes: on the one hand, the development of the green industry and of the green economy sector and, on the other, the demand for new "green skills" in traditional sectors. Technological innovations, environmental policies, the consequences of climate change and new habits of consumption are all factors that determine this new (and growing) demand (fig. 2).
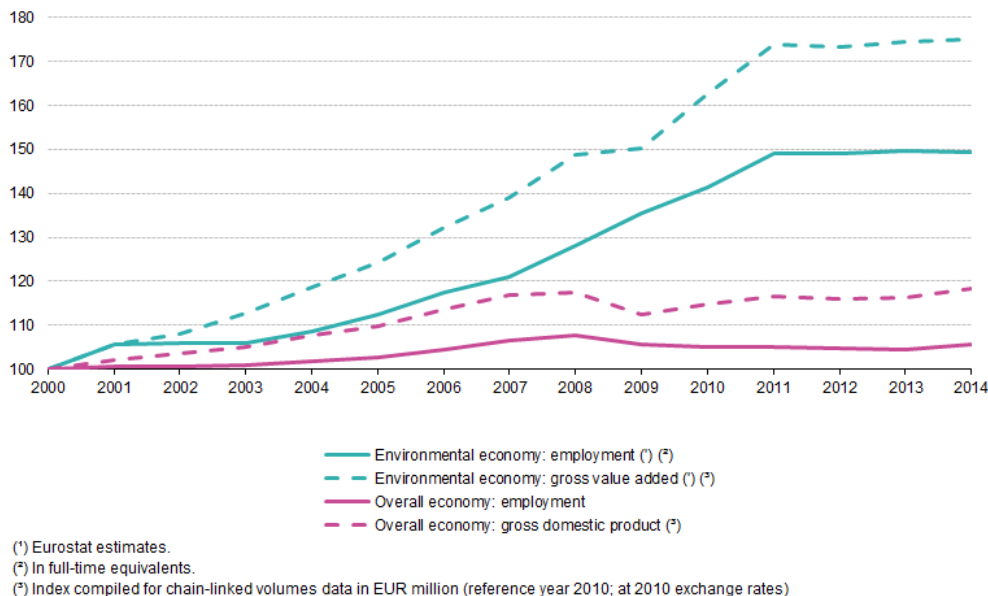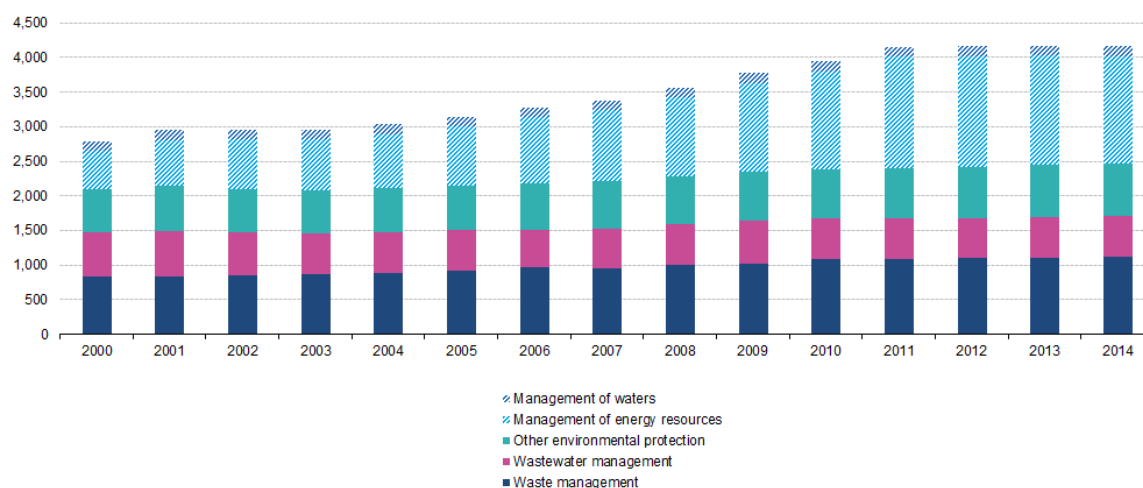

Fig. 2: Growth of the green job market
Source: Eurostat Development of key indicators for the environmental economy and the overall economy, EU-28, (2000-2014).

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4   See Vladimirova and Le Blanc (2015).

The growing number of people employed within the environmental economy since 2000 is mainly due to growth in the management of energy resources, especially those concerning the production of energy from renewable sources (such as wind and solar power) and the production of equipment and installations for heat and energy saving (fig. 3). Achieving quality education on sustainability and extending it to everyone can therefore provide access to new jobs and thus overcome current (or future) forms of poverty caused by unemployment rates, which are lower among more educated people (UNESCO-UNEVOC, 2013). Technology has reduced the demand for medium-skill jobs, such as sales workers and machine operators, because their activities are more easily automated (UNESCO, 2016a).

Note: Data for EU-28 are estimated by Eurostat.

Fig. 3: Employment by environmental domain according to CEPA (the classification of environmental protection activities) *Source*: Eurostat Development of key indicators for the environmental economy and the overall economy, EU-28, (2000-2014).

The implementation of ESD is carried out by the major intergovernmental institutions active in the field of education (e.g. UNESCO, UNECE), by national governments whose task is to develop HE strategies (UE4SD, 2015), and by universities and research centres (UNESCO-UNEVOC, 2013, p. 7). A growing number of working groups, associations of universities, programmes and partnerships have started working on the development of multidisciplinary forms of education to find solutions to the different problems linked to SD (tab. 1)[5].

5   Each has a different focus, for example, ISCN aims at promoting sustainability within universities; SDSN works as an interface between academia and society (2017 – Educating for Sustainability REPORT).

Network name	Website
SDSN- *UN Sustainable Development Solutions Network*	http://unsdsn.org
SDG Academy	https://courses.sdgacademy.org/
IAU-HESD - *International Association of Universities*	http://www.iau-hesd.net/
IARU. - *International Alliance of Research Universities*	http://www.iaruni.org/
COPERNICUS Alliance - *European Network on Higher Education for Sustainable Development*	http://www.copernicus-alliance.org/
HESI - *The Health and Environmental Sciences Institute*	http://www.hesiglobal.org/
GUPES - *Global Universities Partnership on Environment and Sustainability*	http://gupes.org
GULF - *Global University Leader Forum*	https://www.weforum.org
ISCN - *International Sustainable Campus Network*	http://www.international-sustainable-campus-network.org/
WEEC - *World Environmental Education Congress Network*	http://weecnetwork.org/
AASHE - *Association for the Advancement of Sustainability in Higher Education.*	http://www.aashe.org/
UE4SD - *University Educators for Sustainable Development*	http://www.ue4sd.eu
ACU - *Association of Commonwealth Universities*	https://www.acu.ac.uk/
SEPN - *Sustainability Education Policy Network*	http://sepn.ca/
ProSPER.Net - *Promotion of Sustainability in Postgraduate Education and Research Network* (UNIR, UN IAC, Japan).	http://prospernet.ias.unu.edu/
Campus Compact	http://compact.org/
GACER - *Global Alliance of Community Engaged Research*	https://ucpsarnet.iglooprojects.org
GUNi - *Global Universities Network for Innovation*	http://www.guninetwork.org
PASCAL International Observatory	http://pascalobservatory.org
MedUnNET - *Mediterranean professional development network for ESD*	http://platform.ue4sd.eu
GHESP - *Global Higher Education for Sustainability Partnership*	https://sustainabledevelopment.un.org
ULSF - *University Leaders for a Sustainable Future* (United States of America)	http://ulsf.org/
PIURN - *Pacific Islands Universities Research Network*	https://sustainabledevelopment.un.org/partnership/?p=7753
SFA - *Sustainable Futures Academy*	https://yellow.place/en/sustainable-futures-academy-salzburg-austria
MEdIES - *Baltic University Programme*	www.balticuniv.uu.se/index.php/.../doc.../502-the-medies-network-for-esd
MIO-ECSDE - *Mediterranean Education Initiative for Environment and Sustainability*	http://mio-ecsde.org/our-networks/

Tab. 1: Networks on ESD and SD
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

Within this complex framework of different actors, Universities play a central role in education for sustainable development, as well as in networking, and often play a leading role in relation to local populations (Tibury, 2011). There are three main strategies currently in use for achieving these goals and integrating sustainability concerns into university activities:

1. **Classes in Sustainability.** Integration of Sustainability thinking and practice into disciplinary and interdisciplinary courses; specific programmes: Master; PhDs and so on.
2. **Research on Sustainability.** Integration of Sustainability into disciplinary and interdisciplinary research activities related to Sustainable Development Goals.
3. **Green campus**. Most universities with a focus on sustainable development education are also concerned with the practical sustainability of their campus buildings, promoting and leading campus initiatives such as solar panel installation, bike sharing, and a recycle shop to integrate sustainability through both passive and active learning.

The paper will address in greater detail the first strategy: the integration of sustainability into teaching activities.

3. The inclusion of sustainability in HE teaching activities

3.1. Methodologies, tools and learning processes

The very transdimensional nature of sustainability may hinder its translation into educational praxis; moreover it makes the field of ESD very complex and in "a considerable state of flux" (Wortham-Galvin et al., 2017, p. 365). In general terms, ESD is an "umbrella concept" that covers a broad range of themes and aspects to cope with the complexities posed by socio-environmental issues. Such complexities are often grouped into the well-known three dimensions: economic, social, and environmental (fig. 4).

Fig. 4: Matrix of Sustainability: economic, social, and environmental dimensions
Source: http://www.keywordsuggests.com.

In order to foster SD, HE needs to innovate and "transform itself" (Tilbury, 2011). Indeed, the UNESCO report on education and skills identifies "four lenses"[6] (UNESCO, 2012, p. 12) which can foster this transformative process of HE:

1. **An integrative lens** referring to a holistic perspective, which is a prerequisite for taking into account the multiple aspects of sustainability;
2. **A critical lens** interrogating prevalent ideas that could be unsustainable (e.g. the fact that a continuous economic growth is dependent on consumerism and its associated lifestyles).
3. **A transformative lens** leading to real changes and sustainable transformations through empowerment and capacity building.

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6   Cf. "An ESD 'Lens' metaphor is used in this document to guide an educational review process. It encourages 'looking again with new eyes' – in this case looking with 'Education for Sustainable Development' eyes. It helps to see things differently" (Unesco, 2010, p. 4).

4. **A contextual lens** moving from the idea that there is no single way to live or do business which will forever be the most sustainable and suitable for every place. Places and people around the world are different and times will change and, for this reason, sustainability needs to be calibrated according to these differences.

ESD engages universities and colleges in a quest for interdisciplinary and participatory pedagogies and learning strategies, using helpful tools such as "social learning" that "provides an opportunity for the emergence of new solutions within a given dialogue" (Wals, 2009), (Dlouhá et al., 2013, p. 6). Working together and in cooperation is in line with the principles and values of sustainability. As stressed by UNESCO: "For education to be transformative in support of the new sustainable development agenda, 'education as usual' will not suffice. Learning should foster thinking that is relational, integrative, empathetic, anticipatory and systemic" (2016a, p. 34).

To this end, targeted actions can be envisaged within the educational structure. Inside the classroom, every action is related to the interaction between different agents involved in the educational action – instructor, student, and content – thus configuring specific methodological elements. These are defined through two opposite perspectives that interact with each other, helping to implement the level of inclusion of sustainability in the teaching/learning processes (García-González et al. 2016) (tab. 2).

Methodological elements for the integration of sustainability into the classrooms		
1	Teacher-student relationship	Vertical ←→ Horizontal
	The integration of sustainability sets up a process in which the teacher is a mediator who, by implementing the tools for learning, shares the responsibilities for what happens in the classroom with the students.	
2	Competencies	Specific ←→ Transversal
	Sustainability enables the incorporation of specific and transversal competencies. Specific competencies are related to the concepts to be learnt; transversal competencies connect the contents with the surrounding medium.	
3	Socio-environmental issues	Unintegrated ←→ Integrated
	The socio-environmental sphere is highly complex and can be understood from many different perspectives. At the same time, there are also different ways to resolve any given problem. It is necessary to improve the links between socio-environmental issues and knowledge of the discipline, adopting a systematic and interdisciplinary perspective of sustainability.	
4	Resources	Internal ←→ External
	In order to promote sustainability, it is vital to combine all the resources available and their synergies: internal resources and external resources (field trips, dialogue with experts, practice in specific centres, etc.). The environment should enter the classroom, and the classroom should step outside the University.	
5	Evaluation	Accreditation ←→ Procedural
	Accreditation and procedural evaluations are complementary. The former, demanded by the legal context, is a final assessment that is a guarantee to society of what has been learnt. On the other hand, the latter includes information about cognitive, affective, and action-related aspects regarding the process and the participants. It helps to regulate teaching and learning. Students should understand both evaluation processes which help them to reflect, value and improve their capacity to tackle the complexities of socio-environmental problems.	
6	Classroom dynamics	Closed ←→ Open
	Sustainable dynamics allow us to order ideas, to set bases and orientations, but also to give voice to the students and to their own ideas at the same time.	
7	Class work	Individual ←→ Group
	The learning process should encompass two strategies: individual and group class work. The active dialogue between the individual sphere and the collective one is essential to foster the principles of sustainability. The implementation of this dialogue addresses knowledge through negotiation of meaning. In this way, it can be possible to recreate situations in the classrooms that the students will meet during their professional and personal life.	

Tab. 2: Methodological elements for the integration of sustainability in classrooms.
Source: García-González et al. (2016).

According to Filho et al. (2015, p. 20), specific trend change can be identified in ESD teaching (tab. 3)

Shifts from		To be more inclusive of
Discipline focused courses		Inter and multidisciplinary courses
Academic impacts		Social impact
Teaching that informs		Teaching that transforms
Researcher as expert		Researcher as partner

Tab. 3: Trend change in ESD teaching.
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

Literature often provides the most cited definition of sustainable development – i.e. *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs* - without specifying its practical and operational dimension (Boron, Murray, Thomson, 2017). To shape a solution-oriented approach to sustainability and to implement HE activities on these themes, it is interesting to observe how different universities have tackled sustainability issues at the centre of their mission. Best practices come from all around the world and are related to different approaches: whole institute engagement, research focus, integration into curricula, networking (ISCN-GULF, 2017) (tab. 4).

Fields of innovations:	Examples of Best Practices:
Whole-institution approach to educating for sustainability	Sustainable infrastructure developments, volunteering opportunities, sustainability awards, funding for sustainability projects, academic initiatives, internships **(University of Edinburgh)**. Centre for sustainable development that works in five focus areas: teaching, research, operations, transfer, and governance to empower students as change agents **(Stuttgard University of Applied Sciences)**.
Research for sustainability	Campus as a living Lab, supporting the integration of academic and operational work on sustainability **(University of British Columbia)** Transformative and integrative space for students to conduct sustainability-driven research with support from multidisciplinary staff **(The 'Challenge Lab', Chalmers University of Technology)**.
Sustainability across the curriculum	Integrated courses: a broad perspective that crosses all disciplines **(Hong Kong University)**. (see also the *Transdisciplinary Course* of **University of Siena** in the box)
Collaboration to address global challenges	Sustainable Weekend Conference **(Carnegie Mellon University)**; Interdisciplinary, multi-actor working space, underpinned by the principles of transdisciplinary, co-generation and community involvement **(Technical University of Madrid)**.

Tab. 4: Examples of best practices and fields of innovations
Source: the 2017 WEF ISCN-GULF Report.

Transdisciplinary Course on Sustainability at Siena University

Since 2013 the University of Siena has offered a transdisciplinary course on sustainability. With a total of 24 lessons (March to June), the course addresses the basic issues related to the environment, the economy and social and legal-institutional sustainability. It is taught by the University staff and by invited speakers from private enterprises or public institutions. The course is innovative not only because it is transdisciplinary but also because it is offered as an elective course with credits. It attracts an average of 142 students every year with a good gender balance (66 females and 75 males). Target students are BSc and MSc students from any disciplinary programme in the University, technical/administrative staff, external practitioners and stakeholders. The educational backgrounds of students are highly diversified.

Best Practices can provide useful guidelines for other users, but – as shown by the concept of "contextual lens" (UNESCO, 2012) – "each institution has its own unique culture, context, and characteristics and sustainability initiatives should take these factors into account" (Wortham-Galvin et al, 2017, p. 378).

3.2. An analysis of courses offered by International Universities

In order to highlight the main topics addressed by HE courses, we collected data on courses offered by international universities advertised in two of the most relevant career platforms (Prospects and Masterstudies)[7] and in the HESD repository by IAU, filtered by the keywords "sustainability" and "sustainable development". We found 515 courses, including Masters, PhD and Bachelor's programmes. An analysis of the most recurring terms in the 515 course titles shows the general topics (e.g. development, design, food, climate, etc.) addressed by the courses.

The topics are highly concentrated since 50% of the frequency mainly includes (with the exception of the keywords sustainability and sustainable) topics related to: development, energy, planning and design, engineering and technology, climate change. Other relevant topics such as agriculture and food, tourism, policy and leadership, law are relegated to a secondary position (fig. 5).
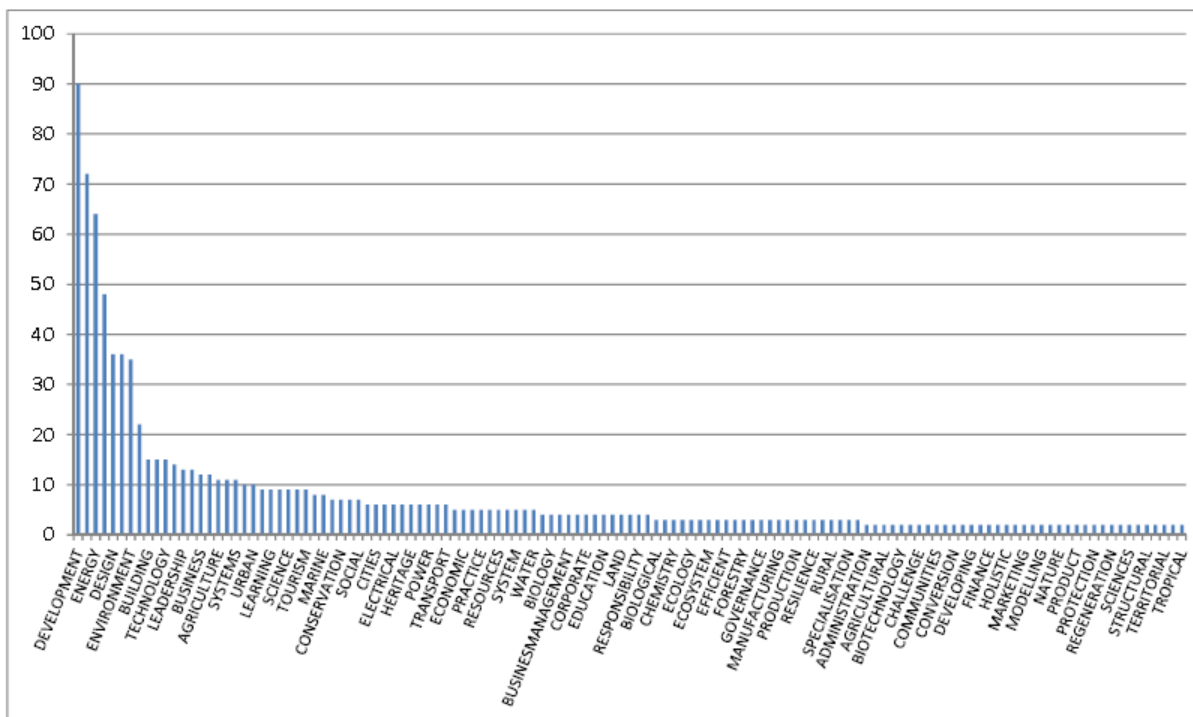
Fig. 5: Word frequency from course title. *Source*: Ladest (Laboratory of socio-geographical research, University of Siena

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7   Cf. https://www.prospects.ac.uk/; https://www.masterstudies.com/.

Moreover if we consider the co-occurrence (frequent occurrence of two terms) of the most recurring terms, the analysis refines the definition of the course topics as shown in the following table. The most frequent topics are: sustainable development, sustainable energy, sustainable management development planning, sustainable design, international development, chemical engineering (tab. 5).

Key term 1	Key term 2	CO-OCCURS	Jaccard	
SUSTAINABLE	DEVELOPMENT	65	0,264	•••••••••••••
SUSTAINABLE	ENERGY	35	0,141	•••••••
SUSTAINABLE	MANAGEMENT	27	0,102	•••••
SUSTAINABLE	DESIGN	18	0,076	••••
SUSTAINABLE	ENGINEERING	16	0,066	•••
SUSTAINABILITY	MANAGEMENT	19	0,123	••••••
SUSTAINABILITY	ENVIRONMENTAL	16	0,12	••••••
SUSTAINABILITY	ENERGY	10	0,065	•••
SUSTAINABILITY	ENVIRONMENT	8	0,063	•••
SUSTAINABILITY	DESIGN	7	0,055	•••
DEVELOPMENT	SUSTAINABLE	65	0,264	•••••••••••••
DEVELOPMENT	PLANNING	8	0,078	••••
DEVELOPMENT	INTERNATIONAL	7	0,071	••••
DEVELOPMENT	LAW	5	0,055	•••
DEVELOPMENT	ENVIRONMENTAL	7	0,054	•••
MANAGEMENT	ENVIRONMENTAL	23	0,24	•••••••••••••
MANAGEMENT	SUSTAINABILITY	19	0,123	••••••
MANAGEMENT	SUSTAINABLE	27	0,102	•••••
MANAGEMENT	ENERGY	7	0,055	•••
MANAGEMENT	RESOURCE	4	0,055	•••
ENERGY	RENEWABLE	12	0,19	••••••••••
ENERGY	SUSTAINABLE	35	0,141	•••••••
ENERGY	ENGINEERING	10	0,114	••••••
ENERGY	SYSTEMS	6	0,09	••••
ENERGY	TECHNOLOGY	5	0,069	•••
ENVIRONMENTAL	MANAGEMENT	23	0,24	•••••••••••••
ENVIRONMENTAL	SUSTAINABILITY	16	0,12	••••••
ENVIRONMENTAL	LAW	4	0,082	••••
ENVIRONMENTAL	DEVELOPMENT	7	0,054	•••
ENVIRONMENTAL	SUSTAINABLE	13	0,051	•••
DESIGN	BUILDING	7	0,171	••••••••••
DESIGN	INNOVATION	5	0,143	•••••••
DESIGN	PERFORMANCE	3	0,091	•••••
DESIGN	SUSTAINABLE	18	0,076	••••
DESIGN	URBAN	3	0,075	••••
ENGINEERING	CHEMICAL	5	0,135	•••••••
ENGINEERING	ENERGY	10	0,114	••••••
ENGINEERING	BIOLOGICAL	3	0,083	••••
ENGINEERING	ELECTRICAL	3	0,077	••••
ENGINEERING	POWER	3	0,077	••••
PLANNING	SPATIAL	3	0,136	•••••••
PLANNING	URBAN	3	0,107	•••••
PLANNING	TERRITORIAL	2	0,095	•••••
PLANNING	INTERNATIONAL	3	0,091	•••••
PLANNING	TRANSPORT	2	0,08	••••
BUILDING	PERFORMANCE	3	0,2	••••••••••

BUILDING	DESIGN	7	0,171	•••••••••
BUILDING	TECHNOLOGY	3	0,111	••••••
BUILDING	COLLABORATIVE	1	0,063	•••
BUILDING	SUSTAINABLE	14	0,063	•••

Tab. 5: Co-occurrence (frequent occurrence of two terms from the title list).
Source: Ladest (Laboratory of socio-geographical research, University of Siena)
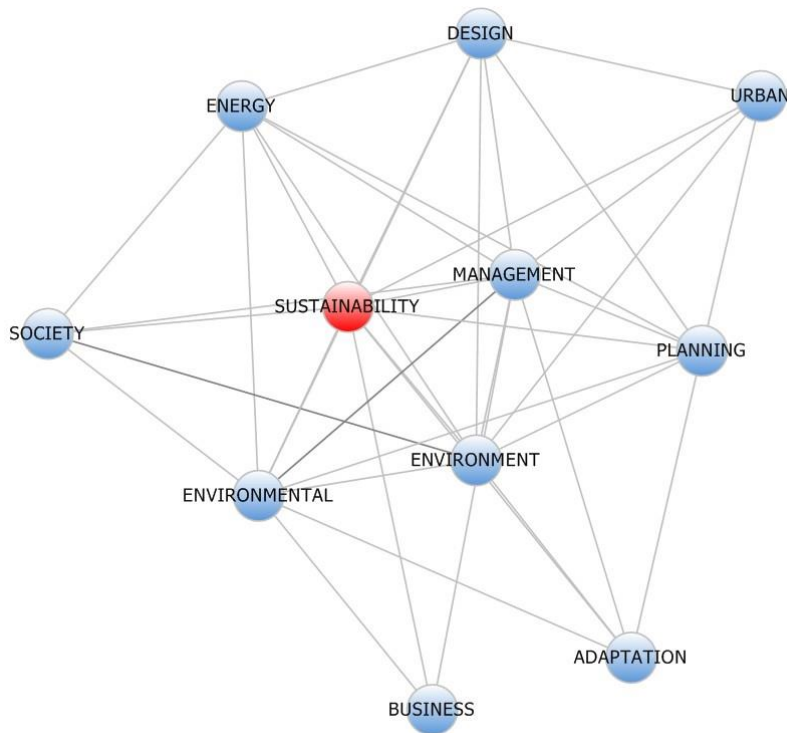
Fig. 6: Co-occurrence graph (frequent occurrence of two terms from the title list).
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

Distribution of the offer is highly concentrated in certain countries and also in some cities whose universities develop a range of activities (fig. 7). It must be taken into account that the data are biased according to the origins of the platform. The high concentration at European level in the UK is due to the fact that the data sources used in the analysis are British.

Sustainabiliy courses
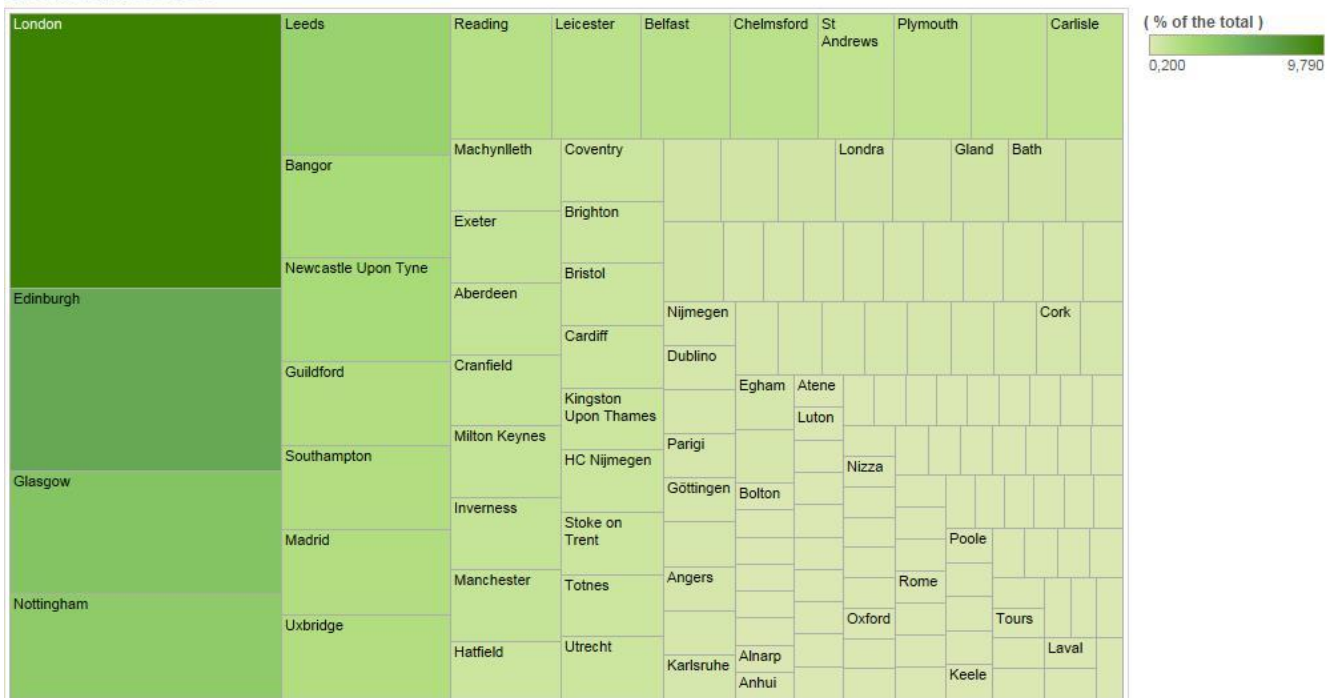
Fig. 7: Distribution of the offer in Prospects and Master studies platforms.
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

4. Sustainability education through Massive Open Online Courses - MOOCs.

4.1. Features and opportunities of MOOCs

Globalization processes have brought significant changes, opening new opportunities for wider access to information and to knowledge. The use of the internet, and its capacity to create large voluntary networks at a very low cost, has created and improved low cost knowledge networks and peer reviewed materials for wide distribution (UNESCO, 2012) and it has also opened up new possibilities in the field of education. The growth of social media and open source platforms facilitates access to education (UNESCO, 2012, p. 24) and allows for the more direct involvement of younger generations (Daniel, Cano and Cervera, 2015), "[p]romising approaches include e-learning on ESD and on-line platforms where young people can share their own ideas and actions on sustainable consumption and sustainable lifestyles" (UNESCO, 2014, p. 22).

In particular, Massive Open Online Courses (MOOCs) are recognized as "one of 30 of the most promising trends in education until 2028" and "the tool for "innovative disruption" that will improve education" (Tirthali, 2016, p. 115). Online courses are capable of overcoming the barriers that distance presents. In this way, they can fill the gap between central and peripheral areas in terms of learning opportunities for these populations and allow low-income students to get access to quality learning without paying or moving away from home. MOOCs can be an enormous opportunity to introduce positive changes also across the developing world, especially as availability expands and the cost of access continues to decline. Online courses could therefore offer a win-win situation for society and for

the environment (reducing the environmental impact of movements)[8]. MOOCs could become an important milestone in the evolution of HE, as a way to reinforce rather than replace traditional universities and their courses (Daniel, Cano and Cervera, 2015).

The first MOOC was started in 2008 at the University of Manitoba in Canada. Despite their high cost of implementation, the number of MOOCs grows at a rate of more than 15 courses per day. In particular, user growth rate is greater than 2000% (160,000 learners at one university in 2011 to 35,000,000 learners at 570 universities and twelve providers in 2015)[9] (fig. 8).
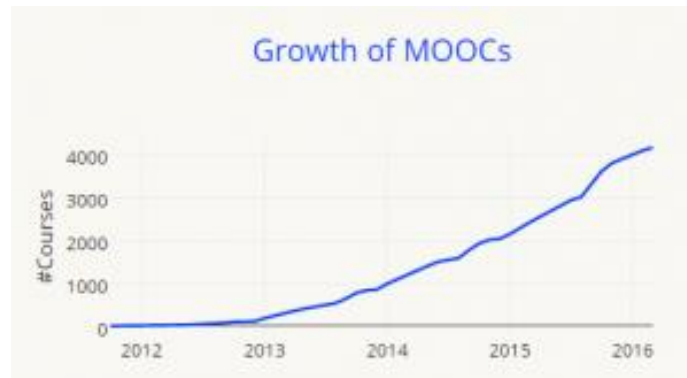
Fig. 8: Growth of MOOCs
Source: *d*learn. European digital learning network on Class Center Data
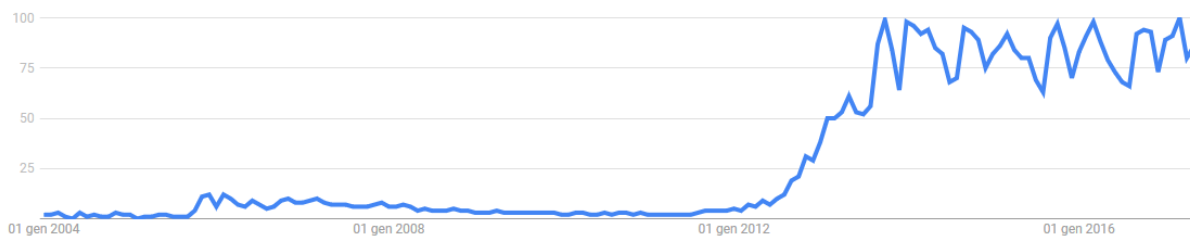
Fig. 9: Increase in Google searches for the term 'MOOC'
Source: Google Trend
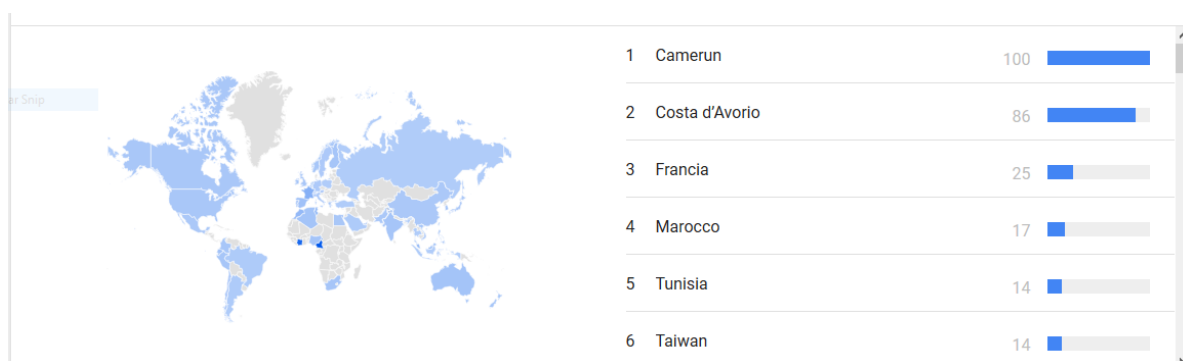
Fig. 10: Geographical distribution of search increase
Source: Google Trend

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8   Of course, the "digital divide" still exists. This term describes a gap in access to and use of information and communication technology. The divide may refer to inequalities between countries or geographical areas, but also between different individual categories (e.g.: the poor/wealthy, young/old, female/male etc.).

9   Cf. http://www.onlinecoursereport.com/state-of-the-mooc-2016-a-year-of-massive-landscape-change-for-massive-open-online-courses/

Whether a MOOC is run by an individual university or a large consortium it can have its own individual design. The courses can combine different teaching methods: lectures, self-study, exercises, and game-like labs. The differences between the courses, their teaching model and the degree of interconnection between teacher and students and within students' groups determine the quality and effectiveness of MOOCs. The main MOOC platforms – such as Edx, Coursera and Udacity – have created an interactive environment that allows learning dynamics: 'many to many, a welcome change for educators who celebrate multiplicity of opinion' (Tirthali, 2016, p. 122). Through blogs, chat, social networks and (in some case) virtual groups, thousands of learners are connected to each other in order to debate ideas, discuss course materials, and get help to master concept.

	MOOCs
Strengths	- Innovation in training and attractiveness to new students, student recruitment, courses for professionals - Flexibility and availability of training - International visibility
Weaknesses	- Underestimation of the organizational aspects - Lack of teacher training opportunities - Other: institutional organization

Tab. 6: Strengths and weaknesses of MOOCs
Source: CRUI (Conferenza dei Rettori delle Università Italiane).

The concept of 'openness' in MOOCs refers not only to free access to material, but also to the wider idea of a whole opening in learning processes, 'breaking down the traditional roles of instructor and student, moving away from prescribed content and encouraging a variety of ways of showing mastery' (Tirthali, 2016, p. 119). "Opening up learning" is the basis of a new "philosophy" (MiríadaX)[10], with specific "principles" (FutureLearner). Thanks to this characteristic of openness, the MOOCs are often presented as "a mission": "to help fund free education for everyone globally" (edX)[11].

MOOCs attract diverse students from different countries. Research on participants' demographics and reasons for enrolling in MOOCs are still rare (Bayeck, 2016). The vast majority of MOOC learners are college degree holders and employed people. Males often constitute the majority of learners but specific studies sustain that the gender gap is related to the type of course taught[12].

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10   Cf. https://miriadax.net/web/guest/nuestra-filosofia.
11   Cf. https://www.edx.org/course/resilient-future-science-technology-epflx-tech4drr.
12   Gender differences in traditional education courses are replicated in MOOCs (Macleod et al., 2014): courses, fields, or majors such as science, technology, engineering, and maths where men are overrepresented in traditional education will experience the same gap in MOOCs.

Learners frequently join a MOOC for educational pursuits, professional development, or to learn new things (Bayeck, 2016, p. 225).

> ## The most recent trends in MOOCs
>
> - MOOCs No Longer Massive
> - Regional MOOC Providers Pick up
> - Decreasing Number of Standalone Courses
> - Increase in Paid Only Courses

4.2. An analysis of MOOCs through the Repository of Education on Sustainable Issues (University of Siena).

The University of Siena has, through the software Semantic Media Wiki, structured a digital repository of MOOCs called ReSi (*Repository on Sustainable Issues*) to understand how world-class universities teach sustainability-related subjects in an open online environment. Using "sustainability" and "sustainable development" in English as keywords, sample MOOCs were searched for on the Platform *MOOC list* which offers a complete list of the main Massive Open Online Courses that have been available on Sustainability since 2015. 139 courses were collected through *ReSi* and analysed in order to conduct a content analysis of the MOOCs identified in the first step. Our repository collects data on the main characteristics of the online courses such as the topics, languages, geographical distribution of the educational offer (fig. 11), and learner interaction (including blog, social networks, etc.).

Fig. 11: Geographical distribution of educational offer.
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

Most of the sustainability-related courses are incorporated on Edx, Coursera, FutureLearn and FUN Platforms (tab. 7).

Platform:	Frequency:	Percentage (%)
EdX	37	26.6
Coursera	33	23.7
FutureLear	21	15.1
FUN	13	9.4
Others	35	25.1
Total	139	100

Tab. 7: Main platforms of sustainability-related online courses
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

In accordance with the study by Zahan et al. (2014), the vast majority of the sample courses provide an introductory level without prerequisites. The average course length is between 4 and 8 weeks, so is shorter than a typical university course. Moreover, the majority of the courses analysed encourage students to attend the course modules from 1 to 4 hours per week. 118 MOOCs issue a certificate, 41 of these at a cost (the average cost of the certificate is between 25 and 150 dollars). Some MOOCs provide paid upgrading that allows unlimited access to the courses and to all the material provided at any point in the future.

Sometimes the MOOCs offer interactive case studies in order to challenge the shared brainpower of course participants[13]. Some courses emphasize peer-to-peer and mentored project-based learning by using a case-study method (e.g. in the course titled "Managing the Arts: Marketing for Cultural Organizations"), designed by the Leuphana Digital School in co-operation with the Goethe-Institut e.V. the participants learned "how to apply theory and marketing strategies to four existing pre-selected art institutions and their real-life challenges"[14].

The analysis of the most recurring terms in the MOOC titles reveal that the topics are – as for courses - highly concentrated but on slightly different topics (fig. 12). Fifty percent of the most frequent terms refer to issues related to: introduction to sustainability, energy, food, and management. It is interesting to note that more theoretical issues appear in MOOCs like resilience, system theory and global issues.

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13   Cf. https://www.canvas.net/browse/centreofexpertise/courses/biobased-economy.
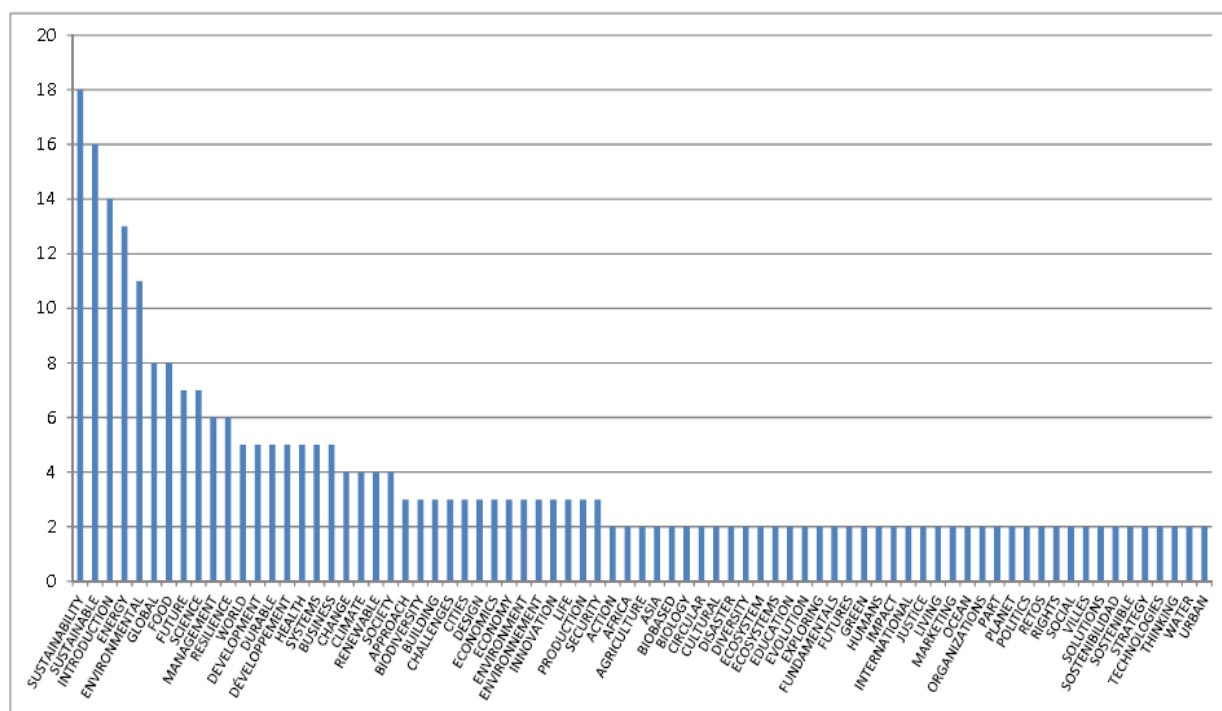14   Cf. http://digital.leuphana.com/courses/managing-the-arts-2015/.

Fig. 12: MOOC topics
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

Moreover if the co-occurrence (frequent occurrence of two terms from the title list) of the most recurring terms is considered, the analysis further refines the definition of MOOC topics (tab. 8).

Key word 1	Key word 2	CO-OCCURS	Jaccard
SUSTAINABILITY	SECURITY	3	0.176
SUSTAINABILITY	SOCIETY	3	0.167
SUSTAINABILITY	FOOD	3	0.15
SUSTAINABILITY	INTRODUCTION	3	0.107
SUSTAINABILITY	RESILIENCE	2	0.095
SUSTAINABLE	DEVELOPMENT	5	0.313
SUSTAINABLE	HEALTH	3	0.167
SUSTAINABLE	MANAGEMENT	3	0.158
SUSTAINABLE	SYSTEMS	2	0.105
SUSTAINABLE	FOOD	2	0.1
INTRODUCTION	ECONOMY	2	0.133
INTRODUCTION	SUSTAINABILITY	3	0.107
INTRODUCTION	ENVIRONMENTAL	2	0.087
INTRODUCTION	TRANSPORT	1	0.071
INTRODUCTION	ECOSYSTEMS	1	0.067
ENERGY	RENEWABLE	4	0.333
ENERGY	ECONOMICS	3	0.25
SCIENCE	ENVIRONMENTAL	3	0.2
ENERGY	FUTURE	3	0.188
SCIENCE	FUTURE	2	0.167
ENVIRONMENTAL	SCIENCE	3	0.2

ENVIRONMENTAL	RIGHTS	2	0.182
ENVIRONMENTAL	CHALLENGES	2	0.167
ENVIRONMENTAL	INTRODUCTION	2	0.087
ENVIRONMENTAL	EXPLORING	1	0.083
GLOBAL	FUNDAMENTALS	2	0.25
GLOBAL	BUSINESS	2	0.2
GLOBAL	ACTION	1	0.111
GLOBAL	TECHNOLOGIES	1	0.111
GLOBAL	DISASTER	1	0.111
FOOD	SECURITY	3	0.5
FOOD	PRODUCTION	2	0.286
FOOD	SYSTEMS	2	0.222
FOOD	FUTURE	2	0.182
FOOD	SUSTAINABILITY	3	0.15
FUTURE	DESIGN	2	0.25
FUTURE	ENERGY	3	0.188
FUTURE	FOOD	2	0.182
FUTURE	SCIENCE	2	0.167
FUTURE	DISASTER	1	0.125
SCIENCE	ENVIRONMENTAL	3	0.2
SCIENCE	FUTURE	2	0.167
SCIENCE	LIVING	1	0.125
SCIENCE	PART	1	0.125
SCIENCE	ACTION	1	0.125
MANAGEMENT	PRODUCTION	2	0.286
MANAGEMENT	SOIL	1	0.167
MANAGEMENT	SUSTAINABLE	3	0158
MANAGEMENT	AFRICA	1	0.143

Tab. 8: Co-occurrence (frequent occurrence of two terms from the MOOCs title list).
Source: Ladest (Laboratory of socio-geographical research, University of Siena)

5. Education and Sustainability in HE: issues and recommendations

A common aim and ambition is certainly to achieve a "Whole Approach to Sustainability" according to which – as suggested by UNESCO (2016a) – Universities should develop curricular and extracurricular activities, teaching and research as well as environment-friendly educational structures. They should also nurture the relationship between the world of education and the wider social context in which they operate, in order to 'become exemplary spaces that breathe sustainability – inclusive, democratic, healthy, carbon-neutral places that lay the foundation for achieving the SDGs' (*Ibidem*, p. 34).
There is still a long way to go, but there are positive signs.
The state of the art and the findings of our analysis on contents and methodologies of courses and MOOCs revealed critical and potential aspects of HE on Sustainability, useful for identifying specific actions in order to implement the role of universities in fostering Sustainable Development at an international level. First of all, ESD plays a pivotal role both in the achievement of sustainable development goals and in the implementation of Agenda 2030. As a consequence, courses, master classes, MOOCs, etc. are burgeoning as well as networks of different key actors (intergovernmental institutions, universities, etc.).
The introduction of sustainability also requires methodological innovations. At present, we are witnessing a shift from purely theoretical perspectives to more "in practice" or solution-oriented approaches, which underline the importance of interdisciplinary and participatory pedagogies, enabling learners to contribute in a variety of ways to a safer, greener and fairer planet for all.

But even so, there is a significant delay in achieving global education commitments (UNESCO, 2016b). Our survey data reveal that most of the teaching is still face-to-face, and rarely uses participatory or multidisciplinary methods, while in the online environment, learner interaction is provided by blog and social networks and through interactive case-studies.

The **introduction of sustainability in HE requires innovations at several levels**, but there are critical aspects which can hinder this process. In particular, our findings suggest a prior difficulty in integrating sustainability courses within existing curricula (65%) as well as a lack of adequate knowledge of the teaching staff (25%) (survey data). Sustainable skills and knowledge should be implemented and applied in theory and practice: new collaborations between hard and soft sciences are needed. It is crucial to increase the weight of social and cultural issues on ESD programmes in order to counterbalance the concentration of training and education programmes on energy and technology. The ongoing situation betrays the leading labour market demand in these sectors, while others (more socially or culturally oriented) seem to be lagging behind. **Trans-disciplinary collaborations and cross-sectoral partnerships** can help in achieving this result. Many educational systems try to expand and improve by diversifying their funding sources (families, fees, public-private partnerships, income-generating activities and donor support). However, the private sector (Prosperity and Profit) should never be over-represented in the partnership, particularly in relation to the other 'two Ps', of Planet and People. Therefore, the coordination of different stakeholders becomes a topic of central concern (UNESCO, 2016a, p. 32).

Both the 2015 I*ncheon Declaration* and the 2016 *Kurashiki Declaration* underline the importance of public funding to ensure quality education for all. More resources are needed to finance education globally (UNESCO, 2016a, p. 31).

Networking and partnership play also a central role in sharing best practices, approaches, and processes in order to support the implementation of ESD. This process of coordination and exchange should be accompanied by a stronger **Global monitoring framework**. In order to realize such a framework, indicators are needed for monitoring the 2030 Agenda for Sustainable Development at global, national and regional level (UNESCO, 2016b). Specific actions can contribute to the improvement of sustainability in HE and to the educational transformation that is required to create a sustainable future as summarized in the following table (tab. 9):

Policy recommendations:

1. Involvement of the whole Institution in ESD instead of individual professors/singular disciplines and increase trans-disciplinary collaborations.
2. Increase the weight of social and cultural issues on ESD programmes.
3. Increase numbers of qualified and knowledgeable teachers.
4. Leverage MOOCs (*Massive Open Online Courses*) to scale up quality learning.
5. Partner with communities, Private sectors at scale (locally).
6. Strengthen global partnership and a Global monitoring framework.

Possible actions to be taken ("*Learn globally, teach locally!*")

1. Assess sustainability literacy locally (see SULITE experience) in order to target courses locally.
2. Develop a sustainability manager for each institution who knows what is going on (at regional or national level).
3. Academic staff training in HE for SD ("pills of sustainability" for different subjects from history to biology).
4. Introduction of ICT (e.g. sensors) and low cost technologies to develop field work (e.g. citizen science projects in biodiversity, environmental quality, etc.) and MOOCs.
5. Create a network of networks to enhance sharing of best practises and materials ("slow teaching" like "slow food communities").

Tab. 9: Policy recommendations and actions.
Source: Survey data - Ladest (Laboratory of socio-geographical research, University of Siena).

6. Annex A – The SDG4-Education 2030 Agenda

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes.

4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education.

4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.

4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy.

4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all.

4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries.

4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States.

7. Annex B - UNESCO policy recommendations on SDG4

Support collaborations and synergies across all sectors and partners.	*Since systemic problems require multiple actors and diverse perspectives, stronger efforts are needed to involve all partners, including ministries, education experts, and civil society, at the local and national level, and across sectors.*
Governments need to view formal and non-formal education and training as key to their efforts to tackle cross-sector problems.	*Education can be an important tool for capacity-building in all sectors. Many SDG targets require specialized skills and expertise that education systems provide.*
Education can help reduce income inequality, but not on its own	*Expanding access by marginalized groups to good quality primary and secondary education will help ensure decent incomes and reduced disparity. Changes to labour market regulations and technology should not penalize workers in less secure jobs, especially in the informal sector.*
Education systems need increased and predictable financing to:	*a) universalize completion of primary and secondary education; (b) increase numbers of qualified, knowledgeable and motivated teachers; (c) provide good quality education to marginalized populations; and (d) prepare for the impact of climate change and the possibility of protracted conflict.*
IMPROVING EQUITY	
Universal primary and secondary education, especially for girls, is central to promoting women's autonomy and decision-making.	*Achieving this target would curtail population growth, transform social norms and practices across generations, and limit the burden on the planet.*
Education policies targeting minority, refugee and internally displaced populations should prioritize appropriate languages of instruction and ensure the use of non-biased curricular and learning materials.	*Building up a pool of qualified teachers proficient in appropriate languages is important in countries with high proportions of ethnic minorities and migrant populations.*
Urban planning needs to involve education planning, and not leave rural areas behind.	*Planning of education, among other basic services, for slum dwellers is vital. Public amenities and good quality teachers should be equitably distributed, and schools made safe and violence free. Rural areas with declining populations and rural school consolidation require planning attention and community involvement.*
CHANGING THE FOCUS OF EDUCATION	
In developing skills policies, education systems should consider both medium- and long-term needs and the implications of sustainable growth	*Teaching green skills to students and providing workers with opportunities to retrain and improve their skills are needed, as are changes in secondary and tertiary level curricula. Better cooperation with business and industry would improve relevance and quality of teaching.*
Civic, peace and sustainability education programmes can be important levers for SDG progress	*Effectively implemented, they can ensure a more equitable justice system, build capacity in judicial and law enforcement, foster less violent and more constructive societies, increase understanding of the links between culture, economy and environment, and prioritize actions that improve the lot of future generations.*

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