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ORIGINAL ARTICLE

Sustainability science in education: analysis of master's programmes' curricula

Janne J. Salovaara[1] · **Katriina Soini**[2] · **Janna Pietikäinen**[3]

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Abstract

Sustainability science is an emerging, free-standing scientific discipline. It has introduced a new approach to both sustainability research and educational programmes, while evoking novel perspectives to stronger societal contextualization. Among several other areas of sustainability research, competencies for sustainability have become a focal topic of sustainability education research. This research explores the educational programmes and the representation of the theory-based key competencies for sustainability. Through a qualitative content study of 45 master programmes associated with sustainability science, we aim to understand what kind of sustainability competencies can be found in sustainability science master's programmes and how they reflect the current discussions of the discipline of sustainability science and possibly drive the future education in the field. The study reveals that commonly suggested competencies including systems thinking, anticipatory, strategic, interpersonal, and normative competencies were frequently mentioned as content and learning outcomes in the curricula and are firmly present and widely employed in sustainability education. Additionally, this study identified three other clusters of competencies: diverse modes of thinking, methodological plurality, and competencies for autonomy. In addition to the contribution to education in the field by suggesting three emerged competencies for sustainability science specifically, we aim to contribute to the ongoing discussion about the discipline by suggesting a process-oriented framing of sustainability science.

Keywords Sustainability science · Higher education · Curriculum development · Competencies · Education for sustainable development · Sustainability professional

Introduction

Sustainability science is increasingly getting attention in academia (Fang et al. 2018). It has even been considered as a new paradigm of science and education (Martens 2006), and can be viewed as an emerging, free-standing discipline. Sustainability science can be simply conceptualised as an academic take on principle-based sustainability, 'as a discipline that points the way toward a sustainable society' (Komiyama and Takeuchi 2006, p. 2). Sustainability science is also becoming widespread as a framing for educational programmes (Lozano et al. 2013). Sustainability science aims to evolve scientific foundations in the broader field of sustainability education or education for sustainable development (Disterheft et al. 2013). In its societal tendencies, it implies a so-called 'fourth function' of universities in their capacity as actors and societal co-creators of the broader sustainability transformation (Trencher et al. 2014). Universities will also need to address the challenge of reaching the Sustainable Development Goals (SDG), which represent a development agenda that will require renewal of curricula with emphasis on competencies clearly related to reaching the SDGs (see e.g., Sustainable Development Goals and Institutions of Higher Education 2019).

Yuto Kitamura, The University of Tokyo Graduate School of Education, Tokyo.

✉ Janne J. Salovaara
janne.salovaara@helsinki.fi

[1] Faculty of Biological and Environmental Sciences, University of Helsinki, P.O. Box 65, 00014 Helsinki, Finland

[2] Natural Resources Institute Finland, Latokartanonkaari 9, 00790 Helsinki, Finland

[3] Faculty of Agriculture and Forestry and Helsinki Institute of Sustainability Science, University of Helsinki, P.O. Box 27, 00014 Helsinki, Finland

The competencies of sustainability have become one of the focal topics for the research of sustainability in higher education, which is where we situate our study as well. Competences, defined as a complex set of knowledge, skills, and attitudes, are important to the development of an emerging field in education (Barth et al. 2007). The bulk of the research focused on sustainability competences aims to elaborate them as specific process-oriented abilities in treating the problem complexes of sustainability (for example: Barth et al. 2007; Heiskanen et al. 2016; Mochizuki and Fadeeva 2010; Tamura and Uegaki 2012; Wiek et al. 2011, 2015). Competencies may assist sustainability science in becoming education with an aim for contributing to a larger scale of societal change, but may also contribute to the institutionalization process of sustainability science as a respective field of science (Meyer et al. 2016).

The majority of the available publications on sustainability competencies are theoretical or based on different forms and sources of literature review (e.g., Wiek et al. 2015). The frequently referenced Wiek et al. (2011) article that focuses on the key competencies sustainability focused graduates ought to possess serves as a landmark for several latter publications on the topic. Some earlier publications have addressed the competences integration of sustainability into education (e.g., Lozano 2006), or framing a whole-person approach to education (e.g., Podger et al. 2010), or weighing the different disciplines and branches of science represented in the vast field of sustainability education (e.g., Jones et al. 2008), while some others have addressed the concept through specific competencies of sustainability through education (e.g., Wals 2010). However, an empirical study of the competencies in the broad selection of sustainability education programmes has been missing.

As new programmes of sustainability education specifically employing the discipline of sustainability science are formed, a thorough look at the key competencies becomes important. Strong focus on sustainability competencies has also received some criticism among the researchers, regarding how they may shape or even narrow sustainability education (Cebrián et al. 2015). For instance, is there a risk in defining the response to sustainability, as education is based on a certain image of the current needs, led by a certain image of the hoped future? (Wals and Jickling 2002). Also, the reciprocal relationship between the theory of sustainability science and the application of the conceptualised competencies in the programmes stays somewhat undefined; are the structures of the programmes based on the suggested competencies? To what extent does the theory of the sustainability science develop based on the programmes in action? Finally, whether sustainability science is as transformative as it aspires to be remains to be seen (Thorén and Breian 2016).

This research studies a selection of sustainability science master's programmes curricula for the employment of the suggested, theory-based, key competencies for sustainability. These competencies are: systems thinking, anticipatory thinking, strategic thinking, and normative and interpersonal competencies. The master's programmes included in this study were selected by featuring definitions of education that is sustainability focused (O'Byrne et al. 2015). The material for this study consists of 1023 individual course descriptions from 45 different master's programmes worldwide. Through a qualitative content study, we aim to answer the following four questions: 1. What kind of sustainability competencies can be found at sustainability science master's programmes curricula? 2. How are the suggested sustainability competences, defined by Wiek et al. in 2015, represented at the programmes? 3. Are there other kind competencies of sustainability emerging from the programmes in operation? 4. How do they reflect the current discussion on sustainability science as a discipline and could they be considered as additional competencies—in reflection of sustainability science specifically?

First, we introduce the theoretical basis of the research by explaining the main frameworks used in the study. Then, we explain the details of the study material and method used. After this, we present the major findings from the materials and suggest three emerging additional sustainability science competencies. Finally, we discuss the findings in reflection to the discipline and field of sustainability science and give some suggestions for future research on the topic.

Theoretical framing

The theoretical frame or the lens we used to explore the sustainability science educational programmes is composed of two parts. The first is how the framing of the competencies for sustainability (explained further) guides the analysis of competencies in the curriculum data. The latter framing of sustainability science (explained further) guides the analysis of the unclassified competencies from the curriculum data.

Competencies for sustainability

Competence-based education focuses on abilities for solving problems in a certain context (Lambrechts et al. 2013), thus key competencies have become focal to the framing of sustainability education. They frame the education as a response to a need for sustainability transformation and as such direct the whole education, including its mode and mission (Lozano et al. 2015). The developments in sustainability education have multiple implications for all aspects of education, not only to the future professionals under schooling, but also to teacher education and the societal subsectors in which the employers are located and the context wherein the new talent is practiced (Dahl Madsen 2013; Vincent and Mulkey 2015). Additionally, one could also assume that the content created in education has implications

for the evolution of the discipline in question through the graduates, who become practitioners of and in the field.

Wiek et al. define key competencies for sustainability as, "complexes of knowledge, skills, and attitudes that enable successful task performance and problem solving with respect to real-world sustainability problems, challenges, and opportunities" (Wiek et al. 2015, p.242). Barth et al. (2007, p.417) in turn, formulate them as "dispositions to self-organisation, comprising different psycho-social components, existing in a context-overlapping manner, and realising themselves context-specifically". Although these definitions are different in form, they capture the same ethos of a purposeful and practical know-how for sustainability (Tamura and Uegaki 2012). Further elaboration of competencies (Wiek et al. 2015) link them more directly to learning outcomes as topics of teaching, such as in a course on systems thinking, or conceptualise them implicitly and as practice, such as part of a project course where systems thinking is applied among other competencies. Although the single competencies are separately framed, they border closely with other competencies and several of them can be embedded in the same learning activity. When reflected after the fact, the competencies obtained seem to capture the whole of the education, rather than trace certain competencies back to any specific course or point of learning (Hansmann et al. 2012).

Along with the development of academic literature on sustainability competencies, several framings have emerged. The competencies differ in their form, but also in their approach to the subject. Where bulk of the competencies can be seen as rooted in the science or the process of sustainability itself (Wiek et al. 2011), some have taken a different angle: a perspective of the higher education institution (Tamura and Uegaki 2012); a perspective of employment in, e.g., industry or business (Heiskanen et al. 2016); or as a framing based on the pedagogical aspects of the taught competencies (Mochizuki and Fadeeva 2010). As many of the suggested framings are based on theoretical elaboration on the requirements of sustainability in education and literature reviews of those elaborations, they are generally all compatible and seem to have many common characteristics.

Wiek et al. (2011, 2015) offer an elaboration on the topic, which also generally captures the other studied competence frameworks from a practical perspective (Barth et al. 2007; Cebrián et al. 2015; Charli-Joseph et al. 2016; Dimity, Podger et al. 2010; Leal Filho et al. 2016; Hansmann et al. 2012; Heiskanen et al. 2016; Karatzoglou 2013; Meyer et al. 2016; Mochizuki and Fadeeva 2010; Steiner and Posch 2006; Vincent and Mulkey 2015). The framework is especially useful for the rich descriptions of the key competences, which are: systems, futures, normative, and strategic thinking and collaboration. Therefore, this framework was also chosen as the starting point for this study (see Table 1).

In addition to all the features above, the ability to justify the need for a given competence to sustainability and the professional activities of it repeats as a feature of all the competencies. To continue, Wiek et al. (2015, p.243) define a sixth 'integrated competence', as a "meta-competence of meaningfully using and integrating the five key competencies for solving sustainability problems and fostering sustainable development". This competence somewhat describes a schematic outlay of the process of sustainability problem-solving framework (Wiek et al. 2011), or the process of sustainability making.

Sustainability science

The second part of the theoretical framing for this study is nested in the current academic sustainability science discourse. In this paper, we scope sustainability science from different perspectives by its plural framings and descriptions.

Concerning the disciplinary framing in the landscape of science, sustainability science has been framed as neither 'basic' nor 'applied' research, implying its transgressive nature between the two, as use-inspired basic research (Clark 2007). It has been defined as a science of sustainability, as compared to a science for sustainability (Spangenberg 2011). The distinction implies that sustainability science is a scientific effort specifically oriented to produce sustainability—the science of sustainability, compared to basic science which can be utilised to advance sustainability (Spangenberg

Table 1 Key competencies for sustainability with definitions (Wiek et al. 2015)

Systems thinking competence	Analyse sustainability problems from different domains and scales
	Apply systems concepts to different contexts (ontologies, structures, effects, etc.) (p. 243)
Futures thinking, or anticipatory competence	Anticipate sustainability issues progression, drivers, and barriers
	Create scenarios, and envision evidence-based sustainable alternatives (p. 244)
Values thinking, or normative competence	Reflect, explain, and negotiate sustainability
	Apply and assess concepts such as justice and fairness (p. 246–247)
Strategic thinking, or action-oriented competence	Employ, develop, and prove strategies for sustainability
	Utilise resources and drivers to overcome barriers (p. 247)
Collaboration, or interpersonal competence	Collaborate with a variety of professionals and non-professionals
	Understand, communicate, negotiate, reconcile, and lead different actors (p. 250)

2011). From the perspective of knowledge production, it can be framed to resemble the mode of Mode-2 science (Nowotny et al. 2001). Sustainability science carries the features of transdisciplinarity and strong societal contextualization and implies systemic change in knowledge production, institutional use, and how it is utilised in the society—thus, transformation (Thorén and Breian 2016). Continuing, that "part of the mission of sustainability science is to determine what knowledge is needed" (Miller 2013, p.285).

Onuki and Mino (2009) suggest that sustainability science might not be a discipline defined by the subjects it deals with, rather by the core principles included, which are holistic thinking, transdisciplinarity, and diversity. The several descriptions of the sustainability science are taken as inclusive characterizations and the ethos of the discipline. Inclusive implies here that these characterizations aim to construct the character and ethos of the science through descriptions of what it is, and what it is for, rather than suggesting an exclusive definition focused on what it is not. Beyond the characterization of sustainability science as a scientific discipline, as by the framing by Clark (2007), the majority of its characteristics focus on the subject matter it treats. Famously described by Kates et al. (2001), p.641), sustainability science "seeks to understand the fundamental character of interactions between nature and society".

From this Jerneck et al. (2011) continued by stating that additional to this understanding, it is an attempt to 'seeking creative solutions to these complex challenges', and Yarime et al. (2012) suggesting that it is "for transforming and developing these [interactions] sustainably" (Yarime et al. 2012, p.101). Further, Dedeurwaerdere (2014) suggested that strong sustainability combines these analytical perspectives 'with a transformational agenda'. As for the functions of sustainability science, it is often addressed to bridge different gaps, like those between "the social system and the ecological system, the social system and the economic system, diverse disciplines, knowledge and action, and of course, the current state and a sustainable future." (Kajikawa et al. 2014, p.437). Or simply put, it is a "discipline that points the way toward a sustainable society" (Komiyama and Takeuchi 2006, p.2).

Thus, the selected dimensions of sustainability science employed to recognise potential emerging competencies from the curricula are human–environment dynamics, strong contextualisation and co-creation, and deliberate aim for transformation (see Table 2).

Materials and methods

Materials

To study how competencies for sustainability are actualized in education, the curricula consisting of programme and course descriptions of selected sustainability focused master's programmes were collected for analysis. The data was gathered through web searches between January and April of 2018 using different combinations of keywords

Table 2 Sustainability science framework dimensions with definitions

Human–environment dynamics	
As a conceptualised system of problems, the problematique, for the sustainability-making process	Understanding complex and dynamic human–nature systems (Yarime et al. 2012) Three domains of global, social, and human levels in conjunction with environment, society, and economy (Tamura and Uegaki 2012) Interactions across domains and scales like nature and society, global and local, past, present, and future (Jerneck et al. 2011)
Strong contextualization and co-creation(inter- and transdisciplinarity)	
As the source, target, and commonality of the sustainability-making process, which in scientific modes implies inter- and transdisciplinarity—as a representation of different worldviews, knowledge(s), and methodologies	A different kind of use-inspired science (Kates et al. 2001) Actionable knowledge co-created to tackle sustainability issues (König 2015), co-creation of solution-oriented transferable knowledge (Vilsmaier and Lang 2015), co-creation of tools and societal transformations (Trencher et al. 2015) Inter- and transdisciplinary field of research (Dedeurwaerdere 2013), holistic, systemic and transdisciplinary for bridging gaps (Becker 2014), transdisciplinarity as a means of transformatively engaging with the world (Lotz-Sisitka et al. 2015)
Deliberate aim to transformation	
As an aim of the sustainability-making process	Commitment to moving knowledge into societal action (Kates et al. 2001) Focus on transition to sustainability (Dedeurwaerdere 2013) Use understanding for transforming and developing world sustainably (Yarime et al. 2012) Use-inspired knowledge for transformational action in participatory, deliberative, and adaptive settings (Wiek et al. 2011)

including, sustainability +science +university +master('s) +program(me) both in incognito Google and master's programmes registries: Mastersportal.com and Findamasters.com. Several hundreds of sustainability-related programmes were initially found. Out of the hundreds of programmes (for example, 602 hits on findamasters.com), 70 programmes that fulfilled the criteria were selected for the preliminary sample.

In selecting the final sample, the criteria for the programmes were: to be university based; mainly taught on-campus; approximately 2 years in workload; granting a master's degree on graduation; and publicly sharing their curricula in the English language. Altogether, 45 programmes fulfilled these criteria. Of these 45 programmes around the world, several mentioned sustainability science as their discipline, and when further analysed using the before mentioned lens, almost as many employed the concept without directly stating to employ the discipline. Out of the 45 programmes, 21 were from European, 19 from North American, 4 from Asian-Pacific and 1 from African countries. Although the documents varied in structure and detail, 537 curriculum documents were considered as representative geographically and content-wise and were included in the analysis. The selected curricular documents consisted of a programme's description, and consisting 1023 individual course descriptions of the programmes core and other mandatory courses with suggested elective courses (for example, a specialisation in sustainability science).

Method

The data were imported and coded in a qualitative data analysis software and the curricula were analysed using descriptive content analysis (Bryman 2012) and more specifically in directed content analysis (Hsieh and Shannon 2005). The curriculum analysis was done using the framework introduced in the theoretical framing chapter. First, the analysis focused on the five key competencies appearing in the curricula, and subsequently on any unclassified competencies which emerged in the study material. The analysed competencies, coded according to the selected key competences framework (Table 1), were extracted from the curricula as they appeared. Although the coding process yielded specific data on the appearance of each specific competence, the quantitative data were not accurate to a number, as the source materials varied vastly between the programmes. However, these appearances could be generally quantified to competences that were comparatively more and less dominant which, by utilising a semi-predetermined coding method, left space for the unclassified competencies to emerge.

In the majority of the codes, the competencies appeared as explicitly worded learning outcomes or as descriptions of the course subjects. In other cases, the competencies appeared through the learning outcomes or as course subjects which, when analysed, revealed a meaning that described a chosen competence. The unclassified competencies were coded by two criteria: (1) a competence was quoted as it resembled the definition of a key competence: an actionable complex of knowledge, skills, and attitudes (Wiek et al. 2015); and (2) a competence had to appear actionable under the chosen lens of sustainability science (Table 2).

The primary analysis of the unclassified competencies took place alongside the coding process. As the competencies appeared in the data, a coding diary was matured, through which a few key clusters emerged. The secondary analysis was made through post-coding, reflecting on the coding diary, with the analytical lens to the content of the coded instances. The quotes under the unclassified competencies were analysed by their content to find both explicit and implicit conceptualizations of these additional key competencies.

Results

Competencies under the existing framework

Studying the curricula yielded ample results under the existing five-point competence framework for sustainability. When comparing the pre-selected and unclassified competence instances (Fig. 1), it is apparent that the studied programmes consistently utilise the suggested competencies.

However, some of the competencies were more frequently present than others (Fig. 1). The most dominant strategic thinking and normative competencies cut through most scientific and applied processes. Wherein, the less dominant systems thinking and interpersonal competencies were present in fewer processes. The least dominant anticipatory competence was often present at a latent scope, but was still utilised least as a specific complex, such as in courses on futures thinking. The anticipatory competence was quoted both through its descriptive temporal scope (the future) and as a specific methodology, although in practice it overlapped with strategic and systemic competencies, which both consider causal relations by their temporal scopes.

Generally, it can be said that the competencies appeared in the curricula in two ways, as a specific learning outcome, or as a subject or topic of teaching (see Appendix tables). For example, systems thinking can appear as a discreet topic studied in a course, or it was simply utilised as a part of a course and its process. An example of the latter type can be seen in project or case study courses, which seem to involve the most competencies at once, for example, 'Interdisciplinary project for sustainable development solutions' at Monash University, or 'Case studies in Leading Change for Sustainability' at Stanford University. Courses structured around interdisciplinary teams, working with real-world examples and stakeholders, with the intent to suggest potential solutions to issues, seem to be both quite typical and the most versatile in teaching

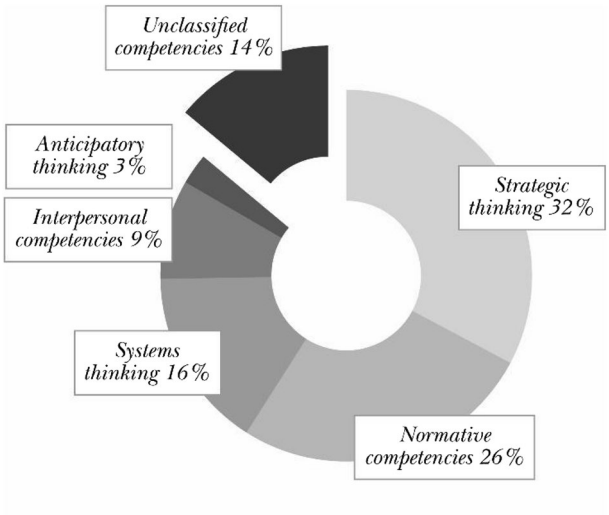

Fig. 1 Proportions of the coded key competencies and all unclassified competencies quoted in programme and course descriptions

all of the competencies at once. Thus, these courses become both contextualised and teach sustainability as an actionable topic. Another example of a course type which had the most instances was those of general sustainability introduction or orientation courses, for example, 'Sustainable Development' at Australian National University or 'Analytical Frameworks in Sustainability Studies' at Linköping University, both of which had all five competencies quoted.

Competences additional to the existing competence framework

Out of the coded unclassified competencies, three main conceptual clusters were formed based on the similarity of the instances within a cluster, and with the aim of further grounding them to the process of sustainability making. These three clusters were labelled as: diverse modes of thinking, methodological plurality, and competencies for autonomy. The majority of the instances fell under the methodological plurality cluster, as competencies of an underlying discipline, such as those from environmental or social sciences and research. However, with this plurality, the quotes often simultaneously spoke of the other two additional competencies: diverse modes of thinking as offering those methods for broadened reflection, and competencies of autonomy as competencies to further the process and cause of sustainability at hand.

Diverse modes on thinking

A competence cluster labelled as diverse modes of thinking arose frequently from descriptions and conceptualization of different kinds of thinking. Diverse modes of thinking could be seen to refer to a generalization of different thinking modes, as well as the different methodologies toward and methods of thinking as a process.

The 'diverse modes of thinking' competence is substantial, as it potentially paves the way for new kinds of knowledge and solution creation, which is vital for treating the complex, dynamic, and unprecedented sustainability problems. This is why it seems to differ in the context of sustainability from conventional or general diverse thinking modes and fulfils the embedded skill–knowledge–attitude complex. Diverse modes of thinking differ from the other suggested competencies in the aim to open the process to different interpretations of the problem at hand including sourcing and suggesting alternative solutions and processes. Where the more structured thinking processes aim to scope the process, diverse approaches help to open the process to those out of the box thoughts and ideas. Diverse modes of thinking can be seen to precede and fluctuate with the more structural systems, strategic and anticipatory thinking at the beginning and throughout the process. Although creativity is not a simple competence to teach, there are methodological approaches that can be practiced which, in effect, could alter and open the process meaningfully, such as synthesizing different methodologies, creating utopias, or employing emotions for inspiration, like empathy.

Methodological plurality

Another competence cluster is labelled as methodological plurality. Methodological plurality arose through several notions of the utilisation of different tools, methods, and mindsets of and for sustainability. Additionally, it can be linked to an individual's knowledge of the different technologies utilised in sustainability as well as developing new tools and methodologies for sustainability.

As mentioned, sustainability and sustainability science are by nature interdisciplinary and methodologically plural. This notion rather describes the process through multiple participants. Here, methodological plurality does not imply that every participant needs to become a jack-of-all-trades, but rather be knowledgeable and reflective toward the other possible, available, and potential methodologies for sustainability. Whether methodological plurality is a group competence, a certain level of knowledge and understanding of the utilised methodologies seems like a requirement. The existing competencies are process oriented. However, methodological plurality can orientate sustainability making towards a more specific type of a process, for example, as a scientific process that is inter- and/or transdisciplinary as well as co-creative. Similar to the other additional competencies, methodological plurality can have multiple placements within the sustainability-making process, though it is most utilised at the planning and execution phase. Which specific methodologies are at the foci is dependent on the

programmes orientation, for example, in environmentally oriented programmes the plurality would imply expanding natural science methodologies to other methodological dimensions of sustainability science.

Competencies for autonomy

The final additional competence cluster is labelled as competencies for autonomy. These arose from frequently appearing descriptions and conceptualizations of self-directedness and ingenuity. Competencies for autonomy could be seen to be directed for both autonomy in self-development and improvement, and as autonomy in self-directedness and ingenuity in other external processes.

As already partially indicated under the suggested meta-competence of operationalisation of the other competences and under each individual competence through a responsibility over self-development, autonomous abilities seem substantially valuable to other sustainability competencies. In addition, competencies for autonomy have linkages to normative competencies, which also reference didactic forms of educating oneself and others of sustainability. In addition to the didactic side of autonomy, there is also the notion of self-directedness, which actualises different parts of the sustainability-making process. Autonomy, in the form of self-resourcefulness, differs from strategic and action-oriented competencies by also suggesting alternative approaches to actualizing one's ideas and plans out of the common structures—for instance—in creating sustainability interventions. For example, in entrepreneurial thinking, competencies for autonomy imply creating an opportunity for a sustainability solution, where no such opportunity is readily available. Rather than entrepreneurial competences understood in a business context, these competencies are utilised as a mindset for self-directedness in the skill–knowledge–attitude complex for advancing sustainability. Competencies for autonomy may weigh in most substantially at the implementation phase of a process, but may also have a role in the planning and ideation stages. Diverse modes of thinking, or self-directedness and resourcefulness, are not simply defined competencies in teaching, but part of a mindset than is obtainable, and through methodological approaches is practicable.

Competences under the sustainability science framework

The initial key competencies introduced by Wiek et al. (2015) can be interpreted to reflect the three selected sustainability science dimensions (Table 2). Observing the additional competencies through their coded content (Appendix tables), we conclude that: (1) systems thinking can be seen as the foundation to the dynamism of human–nature relations; (2) interpersonal competencies suggest the process to be collaborative and negotiated; (3) strategic competence, depending on its utilisation, can also include such collaborative notions, suggest deliberate change as a strategy for a resolution, and entail causal relations; (4) normative competencies, in essence, are present in the deliberate nature of change to sustainability; and (5) anticipatory competencies addresses the causal relations, systems in temporal scales, and note the ramifications of remaining in the unsustainable status quo.

Considering both theory-driven and unclassified competencies in the light of the selected sustainability science framework brings up few key results. The competencies, apart from being all scoped under the broad theme of sustainability, do not define the substance they are utilised under. Sustainability problematique, the dynamics between human development and the environment, as an all-pervasive in a paradoxical manner, frames a certain perspective, rather than creates boundaries to which kind of knowledge and solutions are in focus. Systems thinking defines a perspective and a methodology more than inclusively directing the observation of systems alone. However, reflecting on the next two selected dimensions, the practice of inter- and transdisciplinarity and strong contextualisation and co-creation can be seen to be closely related and embedded in the suggested and the additional competencies. They are in fact descriptions of a process, and as such compatible between the frameworks. From the initial framework, especially interpersonal and normative competencies, the process appears to be collaborative and negotiative. Strategic competence, depending on its utilisation can also include such collaborative notions, although if not further defined—is a matter of choice. Similarly, through anticipatory competencies, the deliberativeness for transformative impact is a matter of utilisation. Anticipatory thinking somewhat overlaps with systems thinking, as systems thinking also considers temporal scales under its dynamic view, and strategic thinking through consideration of the impact of ones' strategic decisions. So, whether anticipatory thinking is utilised to plan for future change or deliberate transformation is situational.

Diverse modes of thinking would imply better consideration of different sources of knowledge(s), inspiration, and perspectives for the dynamic relations between us and our environment. It could also further move the discipline towards the all-pervasiveness and democratization with participation of strong contextualization and co-creation that sustainability requires. Methodological plurality, in being knowledgeable and agile in utilising different tools, methods, and modes of and for sustainability would further expand the process to entail different scientific, applied, critical, and even persuasive modes of sustainability making. Competencies for autonomy, including self-directedness and resourcefulness, may in turn imply a better actualization of sustainability in the deliberate aim to transform the existing realities. Competencies for autonomy could also guide the development of one's professionalism in the field, which would further the development of sustainability science as its free-standing discipline and a professional field.

Discussion

Towards a new framing of sustainability science education

Participation in the United Nations Sustainable Development Goals (SDGs) requires a worldwide curricular renewal at all educational institutions ensuring that knowledge and skills to promote sustainable development are taught (UN 2014). Higher education has a role in educating students capable of systems thinking (Molderez and Ceulemans 2018) and professionals capable of collaborating in different sustainability partnerships—one of the most important SDG meta-goals. Education of sustainability science professionals is part of the whole institution-level process of transformation towards sustainability, which can be strategically planned and assessed using the SDGs as a framework (Korhonen-Kurki et al. 2019).

This monitoring style study confirmed that all five key competencies for sustainability (Wiek et al. 2015) are represented in the sustainability science master's programmes. However, we argue that the three additional competencies: diverse modes of thinking, methodological plurality, and competencies for autonomy are oriented further towards a sustainability science process. They seem to give a more exclusive definition for the content, mode, or aim through which sustainability (making) happens. Furthermore, the integration of the additional competencies to the existing competencies frameworks could potentially develop the framing of sustainability education towards sustainability science.

The suggested, as well as the existing key competencies, mostly remain content specific when given the context and intent of sustainability. However, the additional competencies seem to bridge and operationalise the suggested dimensions of sustainability science and the education thereof. The suggested competencies can also be seen as complementary to the existing ones. Where interpersonal and normative competencies oriented towards collaboration and external reflection, the competencies for autonomy are oriented towards self-resourcefulness and internal reflection, to continue, where system, strategic, and anticipatory thinking suggest certain scopes. The methodological plurality of sustainability science suggests various utilisations of those scopes, and diverse modes of thinking, including some expansion towards other initial approaches to the sustainability problematique—the complex system of problems facing the world (Warfield and Perino 1999).

Integrating the results to a sustainability science theory

Exploring the different framings, it can be suggested that sustainability science ought to reside as neither a descriptive Mode-1 science nor an analytical Mode-2 science alone (König 2015), so it would imply instead that sustainability science is a sum of both and perhaps beyond in being also persuasive (deliberate aims) and critical (through constant assessing and reassessing). It is this fluctuation between the phases that ought to frame the processes and education of sustainability science (see Fig. 2).

The ethos of sustainability science would then develop through a threefold agenda. First, it includes different perspectives, knowledge(s), creativity, and aims in the sustainability problematization—attained through the suggested diverse modes of thinking. Second, it comprises independence for the discipline, professional field, and practitioners of sustainability science—attained through competencies for autonomy to further sustainability. Simultaneously, this could imply that sustainability, as a cause, should have the needed independence, right and priority to transform the existing decision making. Third, it consists of integration of all potential and available methods, modes, tools, and processes to capture the whole problematization—solution process, attained through the methodological plurality competence.

The sustainability-making process exemplified above includes different phases. From descriptively studying the sustainability problematique, this knowledge is then critically explored from plural perspectives and processes. From there, it furthers the contextualisation and co-creation of the suggested sustainability solutions in analytical Mode-2 science process phase. From there, the process moves towards more persuasive applied science, with the intent that it becomes deliberately transformative. From here, processes feed back into the loop for the phase in which the outcomes of the process can be assessed, and newly created situation studied. The suggested three additional competencies emphasise the transformative nature of the sustainability science education. This framing of the process would also expand the discipline itself to consider other forms of science, outside the basic and applied science dichotomy, to critical and Mode-2 sciences.

As limitations to this study, we see language and accessibility to be a significant barrier in collecting a truly global representation of sustainability science master's programmes. To continue, the utilisation of the term "sustainability science" might be not as commonplace even though the programme might by its aims, processes, and contents—be a sustainability science programme. In addition to these, as in any qualitative study, the interpretation of such dynamic concepts as systems thinking or normative competencies as well as the contextual definition between general and key competence in the coding process has to be mentioned as a possible limitation.

Conclusions

This study found that the suggested competencies for sustainability are indeed present and widely employed in sustainability education. This analysis helped to gain practical

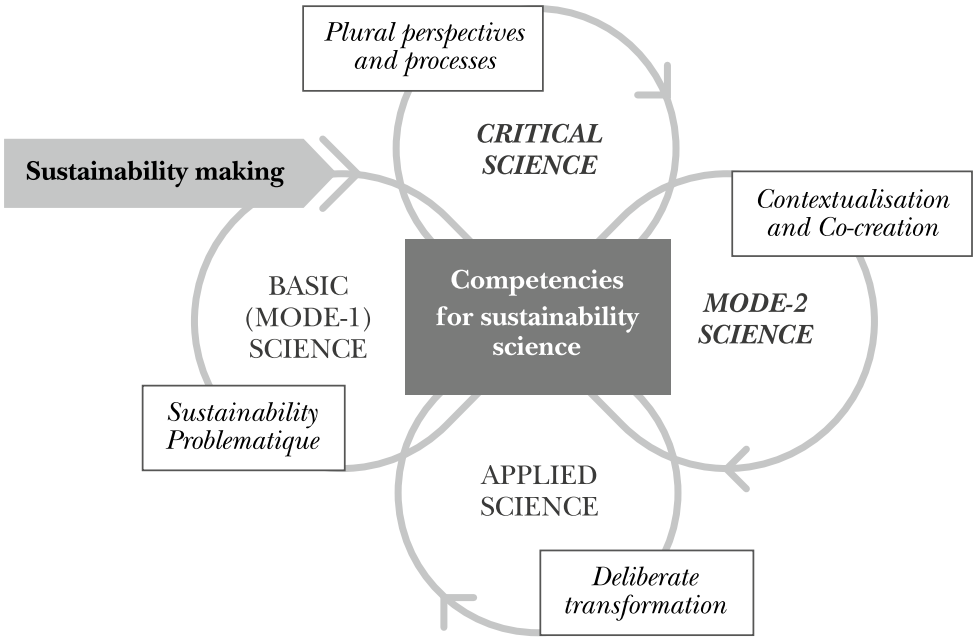

Fig. 2 A sustainability-making process and competencies for sustainability science: diverse modes of thinking, systems thinking, anticipatory competencies, strategic competencies, methodological plurality, normative competencies, interpersonal competencies, and competencies for autonomy

knowledge on how the competencies are utilised in curricula. All competencies of the suggested framework (systems thinking, anticipatory, strategic, interpersonal, and normative competencies) were frequently mentioned as content and learning outcomes of the programmes. Supplementary to the suggested competencies, three clusters of additional competencies were identified from the materials. These competencies are diverse modes of thinking, methodological plurality, and competencies for autonomy. These competencies are suggested as additions to the existing key competencies being specifically sustainability science oriented. They can also be seen to further emphasise the transformative nature of sustainability science in education and as a discipline. Employing these additional competencies could enhance the development of sustainability science as more inclusive, integrated, and independent sustainability science.

However, when defining key competencies for sustainability, one has to be cautious as well. On one hand, the competences are crucial for structuring sustainability education to reflect and follow processes of sustainability transformation, and for the formation of the academic and professional fields. On the other hand, defining them specifically enough to be effectively employed in contemporary education might miss some transformative edge (Wals and Jickling 2002), and stagnate the image of what sustainability could be about (Mochizuki and Fadeeva 2010). Furthermore, defining a mandatory set of competencies, which would wholly reflect the education in practice could be an impossible task. The plurality in sustainability education seems too broad to generalise (Cebrián et al. 2015) and, in practice, the distinction between general competencies of higher education can be tricky to distinguish from the key competencies for sustainability—those critically important for sustainability efforts (Wiek et al. 2011).

Despite these concerns, we see the results of this study important to the future steps of the development of sustainability science for the practice and education of sustainability. Whether or not specific competencies ought to be developed in reflection to the specific needs of sustainability issues at the present, the emerging field of sustainability science allows us to reflect several different aspects of science in society, and its potential to transform and potentially better the state of the world. To do so, we see that future research on the suggested expanded nature of sustainability science as a science that is descriptive and analytic, as well as a critical and persuasive, is needed, both in the context of sustainability science as a practiced and educated independent science.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

See Tables 3, 4, 5, 6 and 7.

Table 3 Existing competencies framework and examples of their curricular appearance

Systems thinking competence	"*Can structure and handle the complex combinations of specific challenges at an organisation level*" Aalborg University "*Renewable energy and the consequences of their use in existing systems*" Leuphana University "*Explore alternative approaches to coupled social–ecological systems from several disciplinary backgrounds*" Stockholm University "*Understanding the complexity of the economic and social phenomena typical of a welfare society*" Universitat Politècnica de Catalunya "*Ecosystem services and understand how private investment and financial mechanisms could accelerate the use of natural infrastructure*" Columbia University "*Analyse feedback mechanisms of climate change on biogeochemical cycle*" Linköping University *"Structure and Dynamics of the major biomes, socio-ecological dimension"* Universitat Autònoma de Barcelona "*Developing skills to integrate evidence into sustainability actions across multiple sectors, systems and scales*" Monash University
Futures thinking, or anticipatory competence	"*Carbon cycle at different time scales and its effects on Earth's temperature*" Schumacher College "*Anticipate future trajectories and apply recognised principles to guide sustainable development decision-making*" Australian National University "*Gain understanding of climate change scenario development, vulnerability assessment and mitigation and adaptation responses*" Australian National University "*Formulate and constructively evaluate low carbon development trajectories*" Linköping University "*Potential, limits, applications, and future development of life cycle management*" Freiburg University "*Political responses and discuss options for future action*" Norwegian University of Life Sciences "*Methods from description/analysis to visioning and strategy building (from knowledge to action)*" Arizona State University "*Examine the science and history of this crisis with a focus on the various policy initiatives and actions being taken globally and locally to both mitigate and prepare for the impacts of climate change"* Pratt Institute
Values thinking, or normative competence	"*Explores the normative framework of sustainability*" Ethics of Sustainability, Arizona State University "*Able to assess the appropriateness of different methods and to show critical judgement when interpreting results of social research studies*" Kiel University "*Negotiate complexity, uncertainty and risk while practicing multi-disciplinary decision making*" Monash University "*Knowledge systems, justice and fairness dimensions of interventions for sustainability*" Australian National University "*Implement, evaluate, and modify as needed the use of measures to achieve transformative change"* Lund University "*Evaluate the transparency and effectiveness of sustainability programs*" Columbia University "*Independently assessing the value and reliability of own science production*" Aalborg University "*Critically relate to and value different actors' visions of a sustainable future"* Uppsala University "*Understand scientific responsibility*" American University of Sovereign Nations
Strategic thinking, or action-oriented competence	"*Analyze and prepare strategies, plans and projects at different levels*" Aalborg University "*Design sampling strategies and collect a diversity of data*" Australian National University "*Understand the need for a strategic approach to corporate sustainability"* Monash University *"Empower students to take a strategic approach when developing a campaign and its communication*" Kiel University "*Work collaboratively to develop strategies promoting wide ranging sustainable solutions*" Columbia University "*Learn the challenges involved with crafting a business strategy and develop strategic thinking*" University of Toronto "*Evidence-based policy solutions and strategies for adoption in a given socio-economic and political context*" Ottawa University "*Deeper insight into the characteristics and drivers of environmental degradation including key political and professional controversies over these issues*" Norwegian University of Life Sciences "*Identify key ecological principles necessary to sustainably manage land resources, and guidelines for implementing these principles in practice*" Central European University "*Current implementation strategies of sustainability communication*" Leuphana University "*Strategies for planning communities that minimize the use of non-renewable energy sources*" Pratt Institute "*Analyses developmental strategies and their geographic dimension*" KU Leuven
Collaboration, or interpersonal competence	"*Can be part of interdisciplinary teams within the field of urban, energy and environmental planning*" Aalborg University "*Possess the according social skills, such as teamwork, conflict management, project management"* Graz University "*Learn to work in teams on projects in disciplines unfamiliar to them*" City College of New York "*The ability to effectively communicate within group and equally to convey the scientific analysis*" Lund University "*Practical skills such as group facilitation, stakeholder analysis and how to design and manage participatory processes*" Australian National University "*Collaboration with scientists from other disciplines*" Christian-Albrechts-University of Kiel "*Stakeholder engagement, networking, group process, and facilitation*" University of Vermont "*Negotiate and integrate their knowledge to develop a context specific and relevant solution to the identified sustainability challenge*" Monash University "*Learn to take responsibility for facilitating dialogue*" Aalto University

Table 4 Examples of "diverse modes of thinking" in the curricula

Creative thinking:

"*Creatively identify issues and integrate knowledge to analyse, assess, and deal with complex phenomena, issues and situations, including anticipating possible futures, even with limited information*" Programme description of Environmental Studies and Sustainability Science, Lund University

"*In a creative way delimit a scientific problem, plan a scientific study, choose appropriate methods, carry out the study, interpret and evaluate the results and, if applicable, generate falsifiable hypotheses to explain the observations all within given time frames*" Degree project in Sustainable Development, Uppsala University

"*Strengthens students' creativity and problem solving skills*" Programme overview of Sustainability, Society and the Environment, Christian-Albrechts-Universitat zu Kiel, Kiel School of Sustainability

"*Think both analytically and creatively about issues of injustice, the environment and environmental health, bringing to bear historical, legal and policy frameworks*" Environmental Justice: Law, Policy & Communities, Columbia University

"*Engage in quality thinking, reflective processes and creative thinking"* Research Design and Methodology, American University of Sovereign Nations

"*The fundamental goal of the class is to cultivate the creative, synthetic, and divergent thinking of students.*" Design Thinking Studio: Experiences in Innovation and Design, Stanford University

Innovative thinking:

"*Exploring new or different areas of investigation linking sustainable development with innovative approaches to harnessing science and technology-based solutions*" Science and Technology for Sustainability Research Seminar, American University of Sovereign Nations

"*Resolve twenty-first century sustainability challenges through innovative and out of the box thinking*" Sustainability Innovations, American University of Sovereign Nations

"*Develop and/or implement innovative ideas in a research context by identifying and formulating hypotheses*" Biodiversity and Socio-Ecological Systems, Universitat Politècnica de Catalunya

"*Will be able to contribute to innovative environmental solutions and help build a sustainable society*" Programme description, Utrecht University

"*Overview of new thinking, innovation and advocacy in public transportation with a focus on passenger transport*" Access, Innovation and the Urban Transportation Transition, Columbia University School of Professional Studies

"*Innovative, interdisciplinary approach, the programme integrates methods and resources from the natural and social sciences, as well as the humanities.*" Programme description, United Nations University

"*Use acquired knowledge as a basis for originality in the application of ideas, often in a research context*" Analysis and Management of Natural Landscapes, Universitat Autònoma de Barcelona

Critical thinking:

"*Develop critical thinking, reading, and research skills*" Sustainability Planning and Assessment, Albert-Ludwig-University Freiburg

"*Identify and critically evaluate the main mathematical approaches to describing populations and growth in organisms*" Introduction to Environmental and Social Research, Australian National University

"*Critically analyze environmental conflicts and social movement strategies*
through a broader cultural and political lens" Nature, Culture, Politics and Justice, Central European University

"*Critically relate to and analyse the history and development of the concept of Sustainable development*" Introduction to Sustainable Development, Uppsala University

"*Define and critically evaluate key insights from holistic science using various examples from philosophy, Goethean science and biology.*" Science with Qualities, Schumacher College

"*Demonstrate critical theoretical and experiential understanding of new approaches to leadership and group facilitation rooted in an ecological worldview*" Leading in the Midst of Complexity, Schumacher College

"*Self reflection on the cosmologies and relationships that we have with the environment in our own communities in the past and today.*" Environmental Ethics, Schumacher College

"*Capable of a critical interpretation of primary scientific literature on contemporary themes in stress ecology and ecotoxicology*" Stress Ecology and Ecotoxicology, KU Leuven

"*Drawing on a critical understanding of approaches to knowledge creation relevant to their academic field, as well as of the significance of epistemological and ontological positions*" Social Research Methods, Norwegian University of Life Sciences

"*Critical thinking about the links between climate change and development*" Climate Change and Development, Norwegian University of Life Sciences

"*Ability to apply, critically and effectively, conceptual frameworks, data collection and processing techniques, applied statistics, mathematical modelling, systems analysis, geographic information systems, information and communication technologies and industrial ecology*" Fundamentals of Applied Statistics and Sustainability and Development Measurement, Universitat Politècnica de Catalunya

"*Critically analyse and assess theories and perspectives on habitat and urban development in developing countries*" Urban and Regional Development, Universitat Politècnica de Catalunya

"*Skills in research and critical thinking that will enable them to pursue a doctorate or further academic training*" Programme description, Trent University

Design thinking:

"*Design Thinking* (…) *combines creativity, human centeredness, design skills, critical thinking, and hands-on building of solutions as an approach to rapidly tackle ill-defined challenges.*" Design thinking for Sustainable Impact, Stanford University

"*Design thinking: applying creative problem solving methods and tools in defining the problem, generating ideas and obtaining solutions.*" Programme description, Aalto University

Alternative and different:

"*Alternative approaches for analyzing how people make choices, use rules, and learn to manage and govern social–ecological systems*" Governance and management of social–ecological systems, Stockholm University

"*Focus on the different forms of knowledge that is used in sustainability debates*" Knowledge-Making for Sustainability, Aalto University

"*Illustrate the complexity involved in creating scientific knowledge and technology for sustainable development, including ethical aspects connected to power asymmetries*" Critical Perspectives on Sustainable Development, Linköping University

"*Develop in students a "*mathematical way of thinking*" or "*mathematical intuition*" as a perspective on social, ecological, and social–ecological systems as they relate to sustainability science.*" Dynamic Modeling for Sustainability Science, School of Sustainability Arizona State University

Table 5 Examples of "methodological plurality" in the curricula

Methodological competencies:
"*The ability to use the various tools and methods.*" Economy and Sustainability, Lund University
"*Encouraged to experiment with and reflect on the use of design and methods tools, and the significance of choices made to the quality of results.*" Social Research Methods, Norwegian University of Life Sciences
"*Develop conceptual and mathematical tools for considering the sustainability and environmental impact of infrastructure projects*" Sustainability in Infrastructure, The City College of New York
"*Conceptual and practical understanding of the application of multivariate statistics in ecology and conservation science*" Environmental Conflict & Collaborative Policy, University of Massachusetts Amherst
"*Efficiently apply mathematical and statistical techniques and tools to analyse and tackle with some of the sustainability challenges*" Fundamentals of Mathematical and Systemic Sustainability, Universitat Politècnica de Catalunya
"*Students learn mindsets, knowledge, and tools that enable them to develop their capacities and identities as change-makers in advancing intergenerational well-being*" Case Studies in Leading Change for Sustainability, School of Sustainability Arizona State University
"*Trains students in multi method research techniques, integrating both qualitative and quantitative tools*" Methods and Practices of Sustainability, Ramapo College
"*Learn to compare different theories in terms of their explanatory power and the kind of innovation problems a theory is able to tackle*" Innovation Systems and Processes, Utrecht University
Technologies and tools, of and for sustainability:
"*Competency in using a cutting-edge statistical software package for data management and data analysis tasks*" Statistical Modelling for Sustainability
"*Learn to use different tools, including dedicated computer software*" Eco-auditing, Aalto University
"*Familiar with the sustainability technologies that large organizations are actively pursuing to solve environmental problems and learn to leverage their skillset to drive organizational change with these technologies*" Sustainability Technology and the Evolution of Smart Cities, Columbia University
"*Role of the media in environmental issues and how society perceives them*" Society and Environmental Change, The Australian National University
"*Learn how to use media for sustainability communication*" Programme overview, Kiel School of Sustainability Christian-Albrechts-Universität zu Kiel

Table 6 Examples of "competencies for autonomy" in the curricula

Self-directedness:
"*Independently take responsibility for own professional development and specialisation.*" Professional development, Aalborg University
"Have the learning skills to allow them to continue studying in a way that will have to be largely autodirigido or autonomous" Fundamentals of Applied Statistics and Sustainability and Development Measurement, Universitat Politècnica de Catalunya
"*Acknowledge the importance of attitude, willingness to learn and ability to plan*" Sustainable Entrepreneurship, Columbia University
"*Experiential learning and on-the-job training have the power to inspire students not only to reinforce the material presented in lectures but also transfer it to the workplace and teach it to others*" Sustainability Management Internship, University of Toronto Mississauga
"*students develop the skills to appreciate and contextualize the approaches taken (and methods used) by others, and during which they can identify the types of specific training they require as they define their own research*" Research Design and Methods for Sustainability, School of Sustainability Arizona State University
"*Self-evaluate and reflect on own values and behaviours in relation to the learning on this module order to improve personal awareness of the Earth as a living system*" The Living Earth, Schumacher College
Self-resourcefulness:
"*Entrepreneurial solutions within the business sector, but we put emphasis also on collaboration with other actors such as non-governmental organizations and the public in the pursuit of systemic solutions*" How to change the world: Innovating towards Sustainability, Aalto University
"*Sustainable entrepreneurship is about entrepreneurs striving simultaneously for profit and for improving local and global environmental and social conditions*" Sustainable Entrepreneurship, Utrecht University
"*Elements of entrepreneurial thinking and methodologies used to determine when an idea may be an opportunity*" Sustainable Entrepreneurship, Columbia University
"*Plan and execute a professional project with a degree of independence and accountability*" Sustainability internship, Monash University
"*Learn to implement practical sustainability initiatives within operating organizations through innovative change management*" Sustainable Operations, Columbia University
"*Basic notions of project management, documentation, planning, tools and methods, procedure models, and agile approaches.*" and
"*Experiential, project based lecture/lab space where participants can explore and develop the complex set of skills and abilities needed for implementing sustainability*" Sustainability Studio, Ramapo College
"*Project lifecycle from the idea and finding funding to the exploitation of research results*" Organisation of Research projects, Leuphana University of Lüneburg

Table 7 Selected programmes

Programme	University	Country	Degree
Master of Environment	Australian National University	Australia	Master of science, Specialisation in Sustainability Science
Sustainability Science	Leuphana University Lunenburg	Germany	Master of Science
Master of Science Programme in Environmental Studies and Sustainability Science	Lund University	Sweden	Master of Science
Sustainability Science	Montclair State University	US	Master of Science
Sustainability Science Master's of Science	Murray State University	US	Master of Science
MPhil in Sustainability Science	University of Ghana	Ghana	Master of Philosophy
Master's degree in Sustainability Science and Technology	Universitat Politècnica de Catalunya	Spain	Master of Science
Environmental Management & Sustainability Science	Aalborg University	Denmark	Master of Science in Engineering: Urban, Energy and Environmental Planning with specialisation in Environmental Management and Sustainability Science
Master of Science in Sustainability	American University of Sovereign Nations	US	Master of Science
Sustainability Science and Society	Brock University	Canada	Master of Sustainability
Environmental Change and Global Sustainability	University of Helsinki	Finland	Master of Science
Sustainability Science	University of Massachusetts Amherst	US	Master of Science
Agricultural, Environmental, and Sustainability Sciences	The University of Texas Rio Grande Valley	US	Master of Science
Creative sustainability	Aalto University	Finland	Master of Arts/Science
Masters in Environmental Sciences, Policy and Management	Central European University (with University of the Aegean, Lund University and Manchester University)	Hungary	Master of Science
Sustainability, Society and the Environment	Christian-Albrechts-Universität zu Kiel, Kiel School of Sustainability	Germany	Master of Science
Master of Science in Sustainability Management	Columbia University Earth Institute	US	Master of Science
Master's Programme in Sustainability Science and Solutions	Lappeenranta University of Technology	Finland	Master of Science
Master of environment and sustainability	Monash University	Australia	Master of Science
Master of Science in International Environmental Studies	Norwegian University of Life Sciences	Norway	Master of Science
Sustainable Environmental Systems	Pratt Institute	US	Master of Science
Master of Arts in Sustainability Studies	Ramapo College	US	Master of Arts
Master of Science in Sustainability	School of Sustainability Arizona State University	US	Master of Science
Sustainability Science and Practice	Stanford University	US	Master of Science
Master of Science in Sustainability	United Nations University, Institute for the Advanced Study of Sustainability	Japan	Master of Science
Master's Degree in Interdisciplinary Studies in Environmental, Economic and Social Sustainability	Universitat Autònoma de Barcelona	Spain	Master of Science, Specialisation in Science and Management of Global Change
Master's Programme in Sustainable Development	University of Leipzig (joint programme with Ca' Foscari University of Venice Italy, Utrecht University, Netherlands)	Germany	Master of Science
Master of Science, Specialisation in Environment and Sustainability	University of Southern Queensland	Australia	Master of Science
Master's programme in Social-Ecological resilience for sustainable development	University of Stockholm	Sweden	Master of Science
Master of Science in Sustainability Management	University of Toronto	Canada	Master of Science

Table 7 (continued)

Programme	University	Country	Degree
MSc Environmental Governance	Albert-Ludwig-University of Freiburg	Germany	Master of Science
Sustainability in the Urban Environment	City college New York	US	Master of science in Sustainability
Master of Sustainable Development	KU Leuven	Belgium	Master of Science in Sustainable Development
MSc in Science for Sustainable Development	Linköpings Universitet	Sweden	Master of Science
Master of Science in Sustainability	Lipscomb University	US	Master of Science
Master of Science in Sustainability	Saint Louis University	US	Master of Science
Holistic Science	Schumacher College	UK	Master of Science
M.A. in Sustainability	Trent University	Canada	Master of Arts
Environment and Sustainable Development	University College London, The Bartlett Development Planning Unit	UK	Master of Science
Master of Arts in Foundations and Practices of Sustainability	Universite de Lausanne	Switzerland	Master of Arts
Master's of Environmental Sustainability	University of Ottawa	Canada	Master of Science
Master of Sustainability	University of Sydney	Australia	Master of Science
Master's in Leadership for Sustainability	University of Vermont	US	Master of Science in Natural Resources with a Concentration in Leadership for Sustainability
Master Programme in Sustainable Development	Uppsala Universitet	Sweden	Master of Science
Sustainable Development	Utrecht University	Netherlands	Master of Science

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