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Article

Public Health and the Environment: What Skills for Sustainability Literacy – And Why?

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Abstract: This paper is an exploration and reflection on the question of what skills, values, attributes and dispositions learners will need to navigate their lives in the challenging conditions of the twenty first century, in relation to sustainability and well-being. First, an overview of the multiple concepts that are considered important for sustainability literacy is gradually built up. These include: multiple 'bottom lines' and contexts of wellbeing, climate change, collective action at various levels, good citizenship, community participation, information technology, psychological aspects, behavioral features and researching sustainability. Secondly, a wide range of skills that learners will require in order to interact with these concepts are explored. The emerging relationships between the given concepts and their attending skills are neither definitive nor prescriptive, but provide an indication of what sustainability literacy could be useful for learners and practitioners in order to enable them to contribute towards the wellbeing of sustainable societies. The paper concludes with that a fundamental overarching skill for sustainability is the ability to work constructively with others in building more sustainable communities, businesses and societies.

Keywords: sustainability literacy skills; environment; public health; climate change; well-being; citizenship; participation

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1. Introduction

'Human health is a subsystem of the Earth's health' [1].

Sustainability is not just an aspect that is important in public health, but rather it is a prerequisite for health. Climate change, the peaking of oil, and ecosystem degradation threaten food shortages, displacements, new disease vectors and resource conflicts, all of which have serious impacts on health. At the same time, the habits of overconsumption which are the root cause of un-sustainability threaten obesity and a variety of mental and physical illnesses related to a sedentary lifestyle. This article considers the skills and attributes that learners will need to gain in order to survive and thrive in the 21st century in ways which contribute to sustainability. These skills and attributes are referred to using the shorthand term of 'sustainability literacy'.

Everyone in society will need to become sustainability literate to cope with the challenges ahead, and in that sense everyone is a 'learner', although this article focuses primarily on university undergraduates. Gaining skills for surviving and thriving in the 21st century goes beyond 'education *about* sustainability', where learners explore what the concept 'sustainability' means and learn some facts about the world situation. Mere knowledge of or information about the alarming un-sustainability of the current trajectory of humanity is insufficient to change that path. Instead, learners need to undertake 'education *for* sustainability', i.e. to have the skills necessary to be effective change agents. This is the acquisition of abilities to work towards changing practices in their own lives, in their workplace, and in their society to contribute towards efforts to increase human wellbeing in a sustainable way. Sustainability literacy, then, is what this article explores; in particular the skills, attributes, competencies, and dispositions to help learners and practitioners navigate their way in the challenging conditions of the twenty first century and contribute to a more sustainable society.

'Sustainability literacy' follows in the footsteps firstly of 'environmental literacy' and then 'ecological literacy'. The thrust has been away from a narrow focus on environmental pollution, towards wider concerns with how the environment can provide basic necessities for current and future generations. As a consequence, the trajectory has been for definitions of the new form of 'literacy' to become less specific and more general in scope. To illustrate, consider Orr's characterisation of 'ecological literacy', which represents a half-way point:

> Ecological literacy…implies a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably… [It also implies] an understanding of concepts such as carrying capacity, overshoot,… thermodynamics, tropic levels… magnitudes, rates, trends of population growth, [and] species extinction... Ecological literacy requires a comprehension of the dynamics of the modern world [2].

Such a portrayal is quite specific in detailing ecological science concepts that students should be familiar with, as well as being general in insisting on a 'broad understanding of how people and societies relate to each other and to natural systems'. In contrast, the later *Forum for the Future*

'definitional framework' of sustainability literacy is at a far more general level [3], where its highest overview states that to become sustainability literate, learners need to:

- Understand the need for change to a sustainable way of doing things, individually and collectively.
- Have sufficient knowledge and skills to decide and act in a way that favours sustainability.
- Be able to recognise and reward other people's decisions and actions that favour sustainability.

The main difference between this definition and Orr's is that Orr is quite specific about what knowledge and skills are sufficient. While over-generalised definitions can be all-encompassing, the benefit of such generalisation is that learners from many disciplines can be included in the common quest for a sustainable future. The term 'literacy' helps reflect this broad application, because all learners (regardless of study subject) and all practitioners (regardless of their direct field of work) are required to be 'literate'. The UK Government's *Securing the Future* plan [4] stipulates that 'We need to make "sustainability literacy" a core competency for professional graduates'. This represents sustainability skills as a universal requirement in the same way that reading and writing skills are.

Although the word 'literacy' is normally associated with reading and writing skills', its relevance in the sustainability debate is that 'It is...a metaphorical use, employed to connote the ability to understand ('read') and influence ('write') society' [5]. Indeed, it is argued that sustainability literacy is the ability to reflect critically on both self and society, and rewrite both self and society in ways which increase human health and wellbeing while simultaneously protecting or enhancing the natural systems which support life. We use this definition as a premise for considering the range of skills that will help learners navigate through the present and future challenging circumstances.

The ownership of the problem of sustainability is complex - on the one hand, ecological destruction is caused primarily by overconsumption by developed countries and by large developing countries which are aspiring to western style consumerism. On the other hand, the countries which are likely to be impacted first and hardest by ecological collapse are the poorer developing countries. It is essential, then, that students in developed countries urgently gain sustainability literacy to help prevent immediate damage to poorer countries and to change the aspirational models which are currently based on consumerism. Sustainability literacy in developing countries is likely to be somewhat different since the questions revolve around immediate survival and campaigning for social justice and compensation from countries which have caused the problem in the first place.

1.1. Aims of the Paper

The aim of this report is to explore the concept of sustainability literacy through asking the question: 'what skills, values, attributes and dispositions would learners need to navigate their lives in the challenging conditions of the twenty first century, in relation to sustainability and well-being?' The specific objectives were to: assess and list the concepts and notions that are considered important for sustainability literacy; and outline the skills and competencies that are considered important for those concepts and notions.

2. Methods

We undertook a review of literature and Internet websites in order to explore, retrieve, itemise and classify the key concepts that are critical to sustainability and well being. The scope was not a systematic review, but a wide and inductive process of broadly mapping the multiple notions that are encompassed in published and internet materials on sustainability. The literature and document searches included using: search engines (e.g., Google/Google Scholar); online databases (e.g., CINAHL, PubMed); relevant websites; and, books (e.g., OPAC system). We also examined the reference lists of the obtained literature or links listed on websites that were useful. The searches employed key words (and their combinations) and allowed for spelling variations. The inclusion criteria were: documents and websites must be linked to the key search terms employed; all conceptual papers and all study research designs; literature available in English language; and, material published from 1975 onwards. However, it is important to note that the work described in this paper was further grounded on a more general and longer-term examination of the literature over many years rather than solely specific searches that were predominantly undertaken for this particular project.

The methods also included a large amount of interactions over the years with sustainability educators in workshops of many kinds. The most important of these workshops was the "*Soundings in Sustainability Literacy*" workshop held at the University of Gloucestershire in the United Kingdom in 2008. This was a national workshop that included 65 educators from a wide range of disciplines who were interested in embedding sustainability into higher education across a range of different curricula. The workshop was organized using Open Space facilitation techniques and insights were fed into the *Handbook of Sustainability Literacy* [6]. Once the concepts that are critical to sustainability literacy were outlined, the next step was to try to identify and reflect on the skills/competencies that would be useful for each concept. Such methodology that employs 'iterative' reflections for pooled judgement is an appropriate method to reach group consensus [7], and has been used in many aspects of health and social care [8,9]. This paper is not intended as an 'empirical scientific' enquiry but rather a far more open-ended, flexible and exploratory work premised on reflection and intuition that are rooted in a wide interdisciplinary knowledge base that is not clearly delineated. As such, the paper expresses a personal point of view from the authors, informed by experience, imagination and reflection. Its 'validity' lies in its ability to stimulate thought and critique in directions that the reader may not have previously considered. Such appreciative type of inquiry [10] seeks the unique perspectives in individuals as an art and practice of asking questions that strengthen a system. Consequently the classification of the points in the findings section below is not based on a systematic way simply because the area is too complex to extract fixed categories from objective reality in a mechanical way. Instead the classification is based on intuition, deliberation, thoughtfulness and reflection.

3. Findings and Discussion

Below we explore in detail each of the notions that emerged from the search, discussions and reflection as well as some of the skills that are considered important.

3.1. Multiple Bottom Lines and Contexts of Wellbeing (Environmental, Cultural, Economic and Social)

Many 'bottom lines' collectively characterize sustainability. Is it one, two, three, four, or how many 'bottom lines'? The multiple environmental, economic, social and cultural 'bottom lines' are all important. Given that these perspectives have similarities and are intricately meshed, what follows is that the skills and competencies required to address them will have common grounds, and are likely to be intersecting and overlapping. Therefore, learners need skills in understanding human social problems within the context of the larger ecosystems in which human, economical, political, ecological, cultural and social systems are embedded. Unless environmental limits are considered, potential 'solutions' to social problems can end up undermining the future of the very people they were aimed at helping. Thus an understanding of both complexity and uncertainty is important, where changes are at the individual level as well as in the social and physical environment. It is about moving the whole system forward by addressing its multiple components: not only by decreasing people's consumption patterns, but also by increasing the natural capital. These multiple bottom lines and considering the whole system despite its complexity, unpredictability and uncertainty collectively underpin many of the skills required by learners in addressing the many dimensions of sustainability [11]. Central to the 'bottom lines' is the notion of well-being with its environmental, cultural, economic and social contexts.

Indeed an important basis of people's mental and physical well-being is related to the environment that is around people: it nourishes them spiritually and provides the essentials of life – air, water, food and fuel [12]. Unsurprisingly, deprived areas are associated with more air pollution, less green space and bio-diversity, and more derelict land. However, well-being and sustainability can both progress together. For instance, 10,000 volunteers of The Green Gyms initiative have discarded running machines to get fit outdoors, and in the process improved 2,500 green spaces across the UK [12]. Collectively, environmental factors affect health, and enjoying the environment helps individuals get active and improves health and well-being. Health is the true wealth of nations, and health and well-being are results of complex processes where an individual interacts with other people and the environment [13].

Related to well-being are poverty, population growth, and urbanization. One billion people live on less than $1 a day, and 2.7 billion struggle on less than $2 per day. Roughly 800 million people go to bed hungry daily. Almost 40% of the world's population does not have basic sanitation, and a billion people use unsafe drinking water [14]. A yearly population increase of 79 million people means that another 1.5 million people need food and a place to live every week (a new city each week) [15]. Furthermore by 2025 about 60% of the world's population will be living in cities [16]. Rapid urban growth bears on a region's economic, social and political fabric, resulting in environmental and social changes, and strains a city's capacity to provide energy, education, health care, transportation, sanitation and physical security. Hence cities have environmental problems and poverty [16].

This multiplicity of factors suggests that uni-causal paradigms are insufficient and over-simplistic. It highlights inter-connected features: multiple determinants that do not occur one at a time, but continuously change and affect each other, creating complex networks of interaction and communication. The multiple exchanges between parts of the system renders it more complex [17]. Hence, tackling multiple determinants from different angles at the same time requires skills in

'systems' thinking (focus on the interactions between factors), whilst recognizing the system's context, circumstances and environment [13]. For instance, skills in understanding the system's structure are important as the system continually adapts to its environment, thus creating learning and progress towards innovative behaviour. Likewise, where stakeholders within a social system contribute from different perspectives and with different understandings of the problems, then meanings attached to actions need to be clearly understood [13]. In addition, power relations between stakeholders need to be comprehended, where players have unequal input in the debate, unequal access to resources and hence differential influence on each other and the system. Skills in unraveling such constructs are useful to facilitate awareness, social learning and innovation. The premise is that with efficient health injury prevention goes ecological development and stronger societal respect for nature's values [18]. These in turn demand an understanding of climate change issues.

3.2. Climate Change Awareness

Several converging crises (e.g., natural resource depletion, oil peaks, ecosystem degradation) are impacting on the Earth's future ability to support human life. But these predicaments are exacerbated by one overarching feature: climate change. Increasingly everyday decisions in personal life, business, and national policy have to be made with climate change in mind, requiring sophisticated skills in analyzing available information, imagining scenarios, and preparing for the worst while hoping for the best. Not even a top climate scientist can be aware of the multiple and varied forms of evidence about climate change which are drawn from diverse disciplines (e.g., entomology, anthropology, indigenous peoples' testimonies). Everyone therefore has to gain skills in critically analyzing the reliability of the myriad available sources which gather information, process it and pose conclusions about the trajectory of climate change. This includes media awareness skills, in order to realize the commercial forces behind media, and its tenancy to provide 'balanced' reports, e.g., a world consensus of scientists as opposed to a solitary contrarian funded by the oil industry. Skills in personal carbon calculating are often proposed (e.g., 'carbon calculator'), but there is a limit to personal voluntary action–it is not going to reduce carbon emissions by the 80%, 90% or 100% necessary to avoid runaway climate change. Hence in addition to skills in personal carbon emissions reduction, learners will need skills in political engagement–from the more conservative 'writing letters to politicians' to more radical direct action (e.g., peaceful protests). These could be termed 'environmental citizenship' skills. Learners need a deep understanding of tipping points and negative feedback so that they can create scenarios for the future. One scenario is that it would be possible to keep global temperature below the tipping point if a collective effort is made, in which case skills in carbon management are extremely important. In another scenario, however, positive feedback sets in and climate change becomes unstoppable, no matter what we do with carbon emissions. In this scenario, skills at adaption become essential. Preparing for both scenarios would be possible if mitigation of climate change is carried out in ways which simultaneously help adapt to it (e.g., through energy efficiency, planting diverse woodlands on flood plains). Preparing for such scenarios requires futures thinking skills to generate the scenarios, and systems thinking in order to consider the changes to social, cultural and economic systems that would be necessary to deal with the differing scenarios. Such wide-ranging changes, in turn, will

necessitate concerted and coordinated actions at multiple levels. A useful way of thinking about the carbon dioxide emissions aspect of climate change awareness is 'Carbon Capability' [19].

3.3. Collective Actions at Various Levels of Governance and Domains of Responsibility

Sustainability is, by definition, not a solitary action, but a function of engagement of many agencies (e.g., NGOs, institutions, governments, voluntary agencies, statutory bodies, corporations, individuals). This is because sustainability requires multidisciplinary actions and inter-sectoral working at local, regional, national, and international levels. Indeed, collective action is required to balance the harmful consequences produced by our excesses for the environment, inhabitants and residents of the world. Therefore co-operation between people and organizations from multiple sectors within a community and across nations is mandatory. This renders sustainability not simple and technical, but a knotty and diffuse social process in which multiple stakeholders have to collaborate together and share information, ideas, decisions, efforts and initiatives. Hence skills in forming and initiating partnerships, coalition building and maintenance, joint-working and expertise in communal collaborative actions are required [20]. Formal and informal alliances of organizations, groups and agencies need a range of partnership fostering skills that are usually not taught to learners during formal education. These include: tolerance, the capacity to actively listen and consult, positive interactions, equally heard voices, management capabilities, flow of information and communication, operational understanding, contributions, awareness among stakeholders of the partnership's benefits, shared responsibilities and a communal sense of ownership. It also entails skills that increase the integration of policy creation and delivery at national and international levels. Such incorporated actions will in turn require motivations that are premised on a strong sense of national and global citizenship.

3.4. Good Citizenship

This is critical for sustainability, even more so in fragile environments, cultures, economies, and societies [6]. A sense of community and social capital are vital to a culture's and country's proper functioning. But today's consuming and individualistic perspectives means that community ties are thinning out. Hence skills in volunteering are becoming increasingly important. Competencies in giving back to the community without taking anything away are critical. Values that underpin people's work for the greater good of others are essential. The willingness of people to give freely their time and skills is what characterizes healthy civil society. This set of skills would include words and actions: friendly approaches, being helpful and considerate, respect for others, helping people who are not in a position to help themselves; and from smiling at people in the street to thanking others, to assisting and representing disadvantaged groups. It also encompasses skills in addressing the inequalities and the social determinants of health; competencies in initiating and developing healthy relationships and networks between people; expertise in tackling the causes of disruptions in the social fabric; capabilities in promoting social inclusion and investing in social capital; proficiencies in encouraging reflection and reverence [6]; and knowledge in building new communities characterised by resilience and mutual trust. All these are facilitated by sound community engagement.

3.5. Community Participation and Local Knowledge Capacities

Community engagement builds on the premise and aspires to develop science and technology locally. Promoting strong relationships with and enhancing the capacities of local communities is at the heart of sustainability. But the philosophy of community participation and ownership demands the stakeholders' appreciation of each other skills and assets, mutual capabilities and worth. It is not about relying heavily on external skills, but rather a diffusion of the skills through the community to achieve a better balance of external versus internal resources. Building community capacity for sustainability through participation would require skills in the regular engagement of local communities about the many issues which may affect them [21]. Such participatory approaches will also need to recognize the impediments of entrenched professional paradigms and unilateral sources of power [22]. Unilateral sources of power are not conducive to people's participation and grass-roots engagement, and partnerships, by definition, entail the minimization of any existing or emerging power differentials between prospective stakeholders and potential partners [22-25]. Hence a transfer of professional expertise to community members may be necessary through mentoring and other training approaches. In community participation for local concerted actions, different sets of resources and skills are required from professionals and community. A citizenry having satisfactory knowledge and skills in social organization and related issues is thus crucial [23]. Stakeholder analysis, multi-dimensional team building, logical framework analysis, and planning and scenario mapping skills are important as is involvement competencies, and introducing and managing change. It is about moving away from an 'us and them' mentality to a collective sense of 'we' [26]. This requires skills in addressing historical differences in power. Involving people early in solutions to climate change and to a sustainability focus will require a good deal of sustainability literacy and information technology skills.

3.6. Information Technology Skills

In the current information age learners spend a significant amount of time in artificially constructed worlds and virtual reality communities. As ecosystems are progressively damaged and the natural world is gradually robbed of its charms, learners might retreat further into this virtual reality. Whether this is 'good' or 'bad', learners will have to develop the awareness of what they have let themselves in for, and the skills to use information technology wisely and appropriately. *Energy literacy* is an important skill–understanding that underlying the virtual reality is a vast amount of electronic equipment that uses energy in all stages of its production, from mining the materials to transporting the parts and components, as well as in its continuing functioning. *Materials awareness* is another factor–understanding the damage to ecosystems caused in the extraction and disposal of materials. Awareness of these factors helps learners make right choices about what software to use–preferably efficiently written software that also extends the equipment's life, and could help to avoid purchasing unnecessary equipment/upgrades. A deeper skill is *cultural awareness* of whose voices are represented strongly on the internet, and those who are excluded. Learners will also need *critical awareness* skills to resist commercial messages that are on the internet (e.g., pop-up adverts and search engine results). Indeed, commercial organisations can pay to have their message appear higher up the list of search results–it is little surprise that entering 'patio heater' into a search engine results in commercial interests encouraging consumers to purchase them much higher in the list than environmental

arguments against them. While commercial interests and people who can afford computers can have a strong internet presence, excluded are voices of millions who are directly affected by environmental destruction. However, compared to print and broadcast media, the internet also offers freedom for some marginalised groups to spread messages without paying huge fees. It is therefore important for learners to gain skills in *New Media Awareness* so that they can seek out voices from groups that are marginalised in the mainstream commercial press and hence gain new perspectives.

The other aspect of new media awareness is the ability to create websites and use social networking sites to spread environmental messages which go against mainstream discourses of economic growth. Social network sites build virtual communities of like minded people working towards a better world, although these communities will suffer a major disadvantage–they are not based in place. When oil peaks, both information technology and basic necessities are going to become far more expensive. The resilience of vulnerable communities to climate change and oil peaks lies in strong relationships between people *in a place*, and learners will need skills in creating a balance between virtual and place-based communities. The internet can be used in ways that facilitate place-based communities, e.g., Free Economy website (www.justfortheloveofit.org) which links local people through skill swapping.

Another aspect of virtual communities is Open Source software [27], and for sustainability it is essential that learners gain skills in using such software, if not actually contributing to making it. Open Source software is created by communities of programmers for fulfilling the needs of the community and anyone else who wants to use the software, rather than commercial software which is mainly for profit. The result is highly efficient programming which significantly extends the lives of computers (does not require regular costly hardware upgrades). Other advantages if learners are skilled in using Open Source software include: no cost, no viruses or hidden advertising, and a range of easily installable software. Finally, where learners swap direct outdoor experience of interacting with people and nature for sitting gazing at a screen, then they will need skills in *IT related health awareness* in order to limit the damage to their physical and mental health. This is particularly important since there are a number of health problems associated with continuous use of electronic equipment as well as psychological issues surrounding lack of contact with nature.

3.7. Psychological Skills

Climate change and a future where energy and resources are severely constrained need preparing for at many levels: the political level, social level, physical infrastructure level, community level, personal level, and, at the deepest, psychological level. Learners will need skills in understanding human psychology so that they can satisfy their own and others' highest human needs in the absence of consumerism or excess material goods. In fact, consumerism is an extremely ineffective way of satisfying higher human needs since shopping generates a temporary 'buzz' which soon wears off and results in more shopping, ending in debt, overwork (to pay the debt), and stress [28]. Learners will need skills in resisting the power of advertising where happiness is equated to more and more purchases, and find genuine ways towards satisfaction. They will need skills in examining the available literature and discovering what research has found about how human needs can be fulfilled. But they can also do their own research for themselves through intuitive reflection–reflecting on

exactly what makes them feel satisfied and fulfilled as people and ways to find more of that. They are likely to discover that 'reconnection to reality' [29] is one of the best ways to fulfill human emotional needs and lead a sustainable life. This may involve re-establishing/improving relationships with friends and family, connecting with nature, or finding meaning through working in ways that align with deeply held values [30-32].

3.8. Behaviour Modification

It is important to understand why behaviour will need to change, the knowledge and skills to behave differently, and the ability to recognise and reward the right behaviour. Sustainability learners would need to gain skills in individual behaviour change, as well as behaviour change within groups, organisations and whole communities. For instance skills in problem-focused approaches to creating change identifies what is wrong with the current situation (the problem), scrutinizes the current situation, investigates potential solutions, and takes action. Conversely skills in solution-focused change search for examples of where the change has already happened (rather than looking at what isn't working) [33]. It is about new vision, values and new attitudes, and there is no right or wrong theory to change management [34]. Many examples exist: Lewin's Three-Step Change Theory [35], Lippitt's Phases of Change Theory [36], Prochaska and DiClemente's Change Theory [37,38], Social Cognitive Theory [39], and the Theory of Reasoned Action and Planned Behaviour [40]. Hence skills in these approaches would be useful. Other methods include social marketing; social support (in spite of the considerable variation in how social support is conceptualized and measured); or more ecological approaches that consciously counter the tendency to solely highlight individual behaviour change process and pay less attention to socio-cultural and physical environmental influences on behaviour [41]. The approaches highlight the influence of perceptions of control over behaviour, self-efficacy, perceived behavioural control, role of social influences, observational learning, perceived norm, social support, and interpersonal influences. However, the effects of the environment on health behaviour need to be also addressed.

3.9. Researching Sustainability (Monitoring and Evaluation, Knowledge Sources, Information Resources and Data Collection Processes)

Sustainability indicators are different from traditional indicators of economic, social, and environmental progress [42]. It is not about measuring changes in one part of a community as if they were entirely independent of the other parts. When communities are finely meshed webs of interactions among environment, economy and society, then sustainability indicators will have to reflect the very tight inter-connectedness between environmental, economic, social and cultural aspects. Whilst economic activity can be measured (regardless of the activity's effect on a community's social and environmental health), for an integrated view of sustainability, multidimensional indicators that illustrate the connections between economic, social, and environmental features are more appropriate [42]. Hence a variety of data sources will have to be employed: from local agencies to town, city or county information; from local motor vehicle registration and housing to public works departments; and from local school boards to public health departments, finance departments and local welfare offices. Both deductive and inductive thinking

skills are required in order to construct a holistic view. What follows is that monitoring and measurement of successes of interventions following a systems approach should therefore employ multi-method evaluations combining quantitative and qualitative approaches [43,44]. These skills are essential. Further, a focus on predefined objectives might result in measurable output but ignores the underlying mechanisms and contexts in which these outputs are created and in which complex processes influence the outcomes [13]. Indeed, the literature on health promotion and wellbeing has recognized the importance and use of multi-method approaches and realistic evaluation methods [45]. Table 1 shows a summary of the concepts that are critical for sustainability literacy, illustrates the diverse skills that are required, and the importance of complexity in change and literacy.

Table 1. Concepts important for Sustainability literacy and the skills required.

Concept	Skills and competencies
Multiple 'bottom lines', many contexts of well-being	Understanding problems within context of larger ecosystems comprising human, political, economical, ecological, cultural and social systems Dealing with complexity, unpredictability and uncertainty
Climate change awareness	Analyzing available information and its reliability Futures thinking skills, Systems thinking Imagining scenarios, preparing for the worst Media awareness and media interests Personal carbon calculating, personal carbon emissions reduction Political engagement, 'environmental citizenship' Understanding tipping points and negative feedback, creation of scenarios Adaption skills
Collective actions, various levels of governance, multiple domains of responsibility	Multidisciplinary action, inter- /multi-professional working, inter-sectoral collaboration Forming, initiating and maintaining partnerships Tolerance, capacity to actively listen, consultation skills Positive interactions, equally heard voices Management capabilities, information flow, communication, operational understanding Contributions, awareness of partnership benefits and costs Shared responsibilities and a communal sense of ownership. Integration of policy creation and delivery
Good global citizenship	Sense of community, building new communities characterised by resilience/mutual trust Social capital, social inclusion, collective perspectives Global social justice Addressing inequalities and social determinants Volunteering, 'giving back' to the community' Friendly approaches, being helpful, considerate Respect for others, smiling at people, thanking others Helping people, assisting/representing disadvantaged groups Reflection and reverence

Table 1. Cont.

Community participation, local knowledge capacities	Community engagement, community ownership Enhancing capacities of local communities, transfer of expertise to community members Appreciation of each other's skills and assets Participatory approaches, involvement competencies Addressing traditional professional paradigms (unilateral power sources) Social organization knowledge/skills Stakeholder analysis, multi-dimensional team building, logical framework analysis Planning, scenario mapping Sustainability literacy
Information Technology	Energy literacy Materials awareness Cultural awareness Critical awareness skills to resist commercial messages New Media Awareness to seek out voices from groups that are marginalised Creating a balance between virtual and place-based communities Using/creating open source software Information Technology related health awareness
Psychological skills	Understanding human psychology Resisting the power of advertising Genuine ways towards satisfaction rather than consumerism How human needs can be fulfilled Intuitive reflection
Behaviour modification	Individual, within groups, organisations and whole communities Problem-focused approaches Solution-focused change A range of change theories Social marketing; social support Ecological approaches Facilitation measures, communication, feedback
Researching sustainability	Multidimensional environmental, economic, social and cultural indicators Multiple data sources Deductive and inductive thinking skills Multi-method evaluations for systems approach Quantitative and qualitative approaches Understanding underlying mechanisms and context

In constructing Table 1, two features were encountered and need to be considered. First, it was not easy (nor desirable) to classify the concepts into strict 'non-interacting' silos (e.g., citizenship, community participation, information technology etc.). There were many overlaps and 'spill-overs',

where a given notion had several implications for one or more cells in Table 1. For example good global citizenship is a concept important for sustainability in its own right; but it also contributes to another notion e.g., community participation and local knowledge capacities, another notion in its own right. Secondly and conversely, the skills required for a given notion were fluid and could service more than one notion, e.g., building new communities characterised by resilience and mutual trust is important for good global citizenship but is similarly critical for community participation and engagement. This suggested that the 'bundling' of certain skills with particular notions/concepts might not be beneficial. Thirdly, subject to overall political environment and prevailing policy directives, some governments/agencies might choose to focus on particular rows in the table more than others. Such practices, although usually necessary due to the breadth of the skills, might be sub-optimal given that the concepts mesh together in an intricate manner.

Another point is that it is challenging to empirically answer the question of what skills learners will need to gain to survive and thrive in the twenty first century (no-one can know what the future will bring). The uncertainty about the future, however, is a starting point, because at least there is assurance that learners will need skills in dealing with uncertainty. Furthermore, trends e.g., population swells, increasing consumption in developing countries, ecosystem degradation, the peaking of oil, and rising greenhouse gas emissions make it difficult for current systems to provide people with their basic needs. Hence, there is certainty that learners will need skills in changing those systems and creativity and ingenuity to re-invent the societies that they live in. Consequently, the method used in this paper utilizes reflection and imagination, where current trends and potential directions are considered, and matched against skills which appear to be necessary for dealing with a range of possible futures. The method is backed by information about trends gathered from scientific literature, although this information is, of course, incomplete and changing all the time.

This paper has limitations. The skills described in this article are not authoritative. It is also challenging to objectively validate them. However, the process of reflection and imagination based on knowledge of current trends is better that simply assuming that the future will be very much as the present is today. The robustness of our findings is increased because the paper premises on an extensive literature search as well as a large amount of interactions with sustainability educators in workshops of many kinds over years. Nevertheless, the findings are the authors' views and not definitive statements, but a turn in an ongoing dialogue, a collective reflection, and the reader is invited to be skeptical and critical of the findings, and to join in the reflection.

4. Conclusions and Implications

This paper described sustainability literacy skills: a wide range of skills that the authors consider important for learners in order to contribute to sustainability in the twenty first century. However, the exploration we depict is incomplete, and there are many gaps. Exploration of sustainability literacy is something that can never be complete, particularly since the changing conditions of the world will continuously require new and different skills. Besides the specific findings of the paper, what is critical is the process of asking and reflecting deeply on the question of what skills learners will need in the future to deal with life in the world around them. This is a question that all educators and practitioners will need to reflect on. An education system which prepares learners with the skills they need to

navigate the world as it is right now, or as it was twenty years ago, is simply not up to the task of preparing learners for the rapidly changing conditions of the twenty first century. In particular, the array of issues surrounding peak oil, climate change and ecosystem degradation make continuity of current social and economic systems unattainable, so learners must be skilled in either changing the trajectory of society or adapting to a very different world if the trajectory cannot be changed. The question of how learners can practically gain sustainability literacy skills is an important one, and is discussed in detail in the book *The Handbook of Sustainability Literacy: skills for a changing world* [6]. In this book, practitioners from a wide variety of disciplines describe active learning exercises based on real life scenarios that can help them gain many of the skills described in this article. Above all, the book shows that sustainability literacy is relevant and applicable right across the curriculum from anthropology to computer science.

Understandably it would be quite impossible for individual learners to gain the entire range of skills described in this paper. However, a fundamental overarching skill for sustainability is the ability to work constructively with others in building more sustainable communities, businesses and societies. If all learners can gain skills in co-operative working then each one needs no more than a subset of the skills described in this paper, together with a wide vision that encompasses the intricacies of the situation that we find ourselves in. The ultimate aim is not, of course, sustainability literacy, but the creation of more sustainable societies, something that can only be accomplished if learners gain the skills they need for surviving and thriving in the twenty first century.

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