Toward the Development of Robust Learning for Sustainability Core Competencies

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Introduction

While improving quality of life has long fascinated humans, there has recently been a growing interest among communities, schools, and governments to create sustainable well-being societies.[1,2] The global sustainability movement has aimed to educate people about the interconnectedness of consumption and production, environmental quality, climate change, loss of biological and cultural diversity, economics, ethics, and human behavior; and engender improved quality of life through sustainability education that is accessible to all, environmental protection, responsive governance, improved health care, meaningful work, enhanced equity, peace, partnership, and social justice.[3–6] Within the higher education setting, successful implementation of transformative sustainability declarations and commitments such as the Earth Charter,[7] the Climate Commitment,[8] the Talloires Declaration,[9] the UN Sustainable Development Goals,[10] and UNESCOs Global Action Programme[4] will require a radical shift in the mission, purpose, and structure of higher education institutions. This is demonstrated by the fact that many academic institutions still focus more on greening of the campus than on a more immersive and comprehensive approach[11] that integrates and infuses sustainability across both curriculum and research, thereby building rich and robust campus cultures of sustainability that take improving quality of life for all, on campus and beyond, as their raison d'être. Taking this latter approach focuses attention on the communication, curricular, pedagogical, policy, and institutional changes that are necessary to produce meaningful, transformative behavioral change in the wake of complex and highly interconnected economic, environmental, moral, and societal sustainability challenges.

Many authors have highlighted the importance of formal education and the specific role of higher education in training citizens and future educators to disseminate this critical knowledge.[12,13] A better understanding of human capacities, capabilities, and competencies for facilitating this societal transformation toward sustainability, and an improved understanding of how we can promote their development through learning and formal education, are crucial to the success of this venture.

As is the case with many emerging and growing domains of learning, there have been logistical, conceptual, and institutional obstacles regarding the integration of sustainability into formal education, and the integration of education into sustainability initiatives. Despite the dramatic increase in sustainability programs within higher education institutions, there is no standardized tool or measurement system by which to assess competency in sustainability or sustainability literacy. Thus, with the increased manifestation of sustainability-related disciplines within the higher education curriculum, especially at the graduate level, the need for well-defined, overarching competencies, regardless of the interdisciplinary nature of the field, is readily apparent.

According to an article by Vincent and Focht,[14] the National Association of Environmental Professionals (NAEP) and other similar organizations advocated for the creation of

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core competencies in sustainability. Despite agreement by many organizations that this is a necessary step toward the development of well-regarded, evidence-based academic programs in sustainability, no existing program model has emerged as an exemplar and no consensus on standard core competencies has been established. As a result, there is no formalized notion of core competencies for sustainability or how they should be developed or taught, potentially minimizing the legitimacy of sustainability education amidst the ever-growing development of sustainability-oriented academic programs.

Students and staff at Western Michigan University's Office for Sustainability have immersed themselves in the existing literature on core competencies in education for sustainability in order to help develop evidence-based best practices in education. This meta-analysis of the existing literature was developed in conjunction with a workshop presented at the 2013 Association for the Advancement of Sustainability in Higher Education (AASHE) conference, profiled here.

AASHE Workshop

On October 6, 2013, the authors presented a half-day Learning for Sustainability Core Competencies workshop at the national Association for the Advancement of Sustainability in Higher Education (AASHE) conference in Nashville, Tennessee. The development of Learning for Sustainability (LfS) core competencies is a critical step for fostering deep, immersive campus cultures of sustainability and for preparing students to respond effectively to the many interconnected environmental, economic, moral, and societal challenges associated with improving quality of life for all. Understanding LfS core competencies and how to promote their development through learning and behavioral change involves a radical shift in the mission, purpose, and structure of higher education institutions.

Prior research on sustainability core competencies supports the notion that competencies are built from a combination of relevant knowledge, attitudes, values, and skills.[15-17] The authors, however, posit that there is also something else, perhaps some less tangible meta-glue, that binds these competencies together.

Despite an abundance of research on the topic, this is a relatively new area of study and there is no consensus regarding what these competencies are. Numerous gaps persist in the literature due to limited development and different interpretations of the term *competencies*, no less the term *sustainability*. Thus, the workshop aimed to better define and expand upon the content of LfS competencies and to further the process of clarifying existing gaps. The formal workshop goals were to:

1. Increase the sophistication of the discussion around LfS core competencies
2. Foster bridging the gap between our stated aspirations for a sustainable and desirable world and our generally unsustainable actions, lifestyles, policies, and institutions
3. Begin building a community of practice around developing, testing, evaluating, and refining LfS core competencies

The workshop was attended by more than 100 participants, who self-organized into 10 groups based on their placement at large round tables in the conference room. In order to better ascertain the workshop participants' baseline perspectives on core competencies and sustainability, initial assessment data was acquired utilizing an interactive, electronic survey program called Poll Everywhere. Prior to the workshop, survey questions were entered into the Poll Everywhere website. Over the course of the workshop, participants were able to respond to questions posed by the authors directly through the Poll Everywhere website or by texting their responses to the website server.

To establish context and the participants' frames of reference, we, the workshop facilitators, first presented two sustainability definitions and asked participants the extent to which they agreed or disagreed with those definitions. The first definition, from the World Commission on Environment and Development (WCED), is an extended version of the most frequently cited *Our Common Future* definition, which states:

> Humanity has the ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits—not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology

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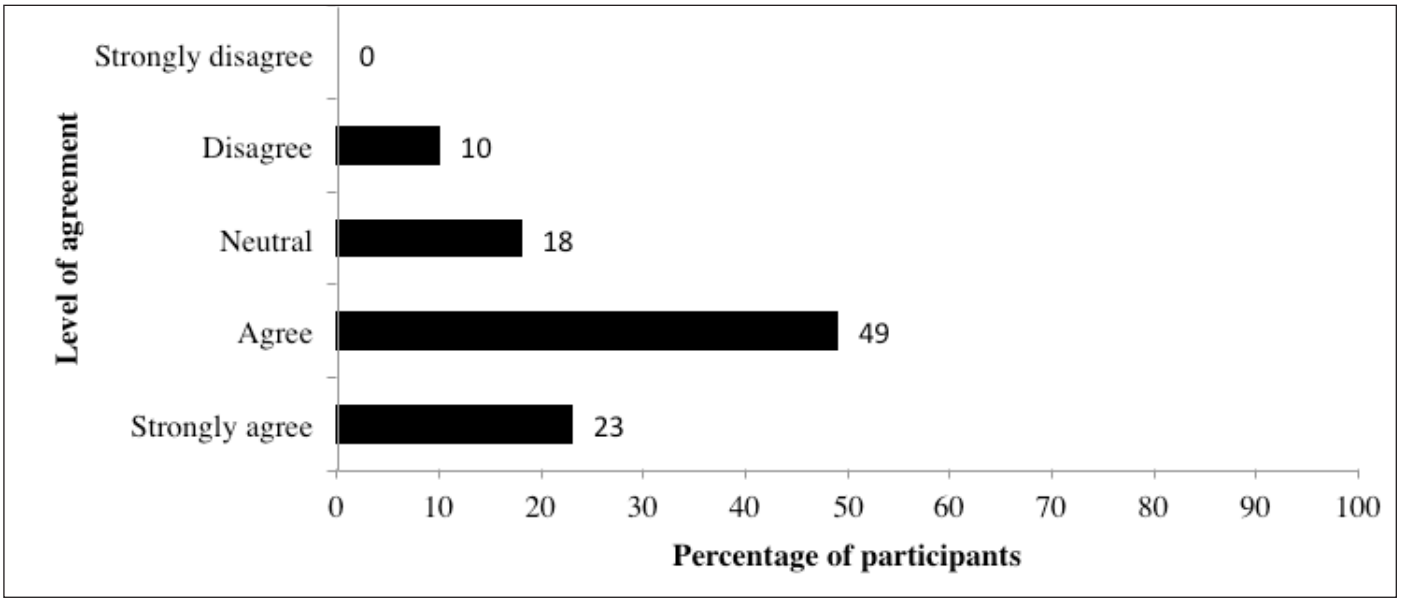

Figure 1. Participant level of agreement with the WCED sustainability definition

and social organization can be both managed and improved to make way for a new era of eco-

Of 94 registered workshop participants, 57 participated in the first poll, which asked, "What is your level of agreement with [the above] definition?" Results are reported in Figure 1.

A second sustainability definition, by Meadows, Meadows, and Randers, was also posed to the group:

> A sustainable society would be interested in qualitative development, not physical expansion. It would use material growth as a considered tool, not as a perpetual mandate. It would be neither for nor against growth, rather it would begin to discriminate kinds of growth and purposes for growth. Before this society would decide on a specific growth proposal, it would ask what the growth is for, and who would benefit, and what it would cost, and how long it would last, and whether it could be accommodated by the sources and sinks of the planet (p. 210).[19]

Participants were asked to rate their level of agreement with this definition as well. For this poll, 64 participants voted. The results are shown in Figure 2. There was little difference between the levels of neutrality and disagreement in either of the presented definitions. However, many more participants "strongly agreed" with the Meadows et al. definition than with the WCED definition. The authors propose that the much larger percentage of strong agreement with the Meadows et al. definition suggests that these participants had a more subtle, critical, and nuanced understanding of economic growth. This may extend to recognizing that certain forms of economic growth may be inimical to the goal of improving quality of life for all.

The third technique for understanding participants' frame of reference was to present two common visual representations of sustainability (see Figure 3). These two representations depict alternative relationships among economy, society, and the environment using two sustainability lenses. Participants were asked which visualization best reflected their conceptualization of this relationship.

Sixty-three participants responded to the poll featuring the two visualizations, with results shown in Figure 4. More respondents generally preferred diagram B (54%) than diagram A (41%). The authors inferred, based on prior correlational analysis, that individuals preferring Figure B tend to have a higher level of sustainability literacy. Those partial to diagram B typically view any viable economic systems as wholly owned subsidiaries of the environment—they see the planet's real carrying capacity as having limits and they profoundly appreciate the irreplaceable role the environment plays in supporting human flourishing. These individuals tend to recognize that while technology can expand carrying capacity limits, these gains can be overrun by consumption increases (due to population growth, real per-capita consumption expansion, or both) as well as efforts to mitigate unintended consequences (desertification, climate change, pollution, loss of biological and cultural diversity, etc.). Simply put, all

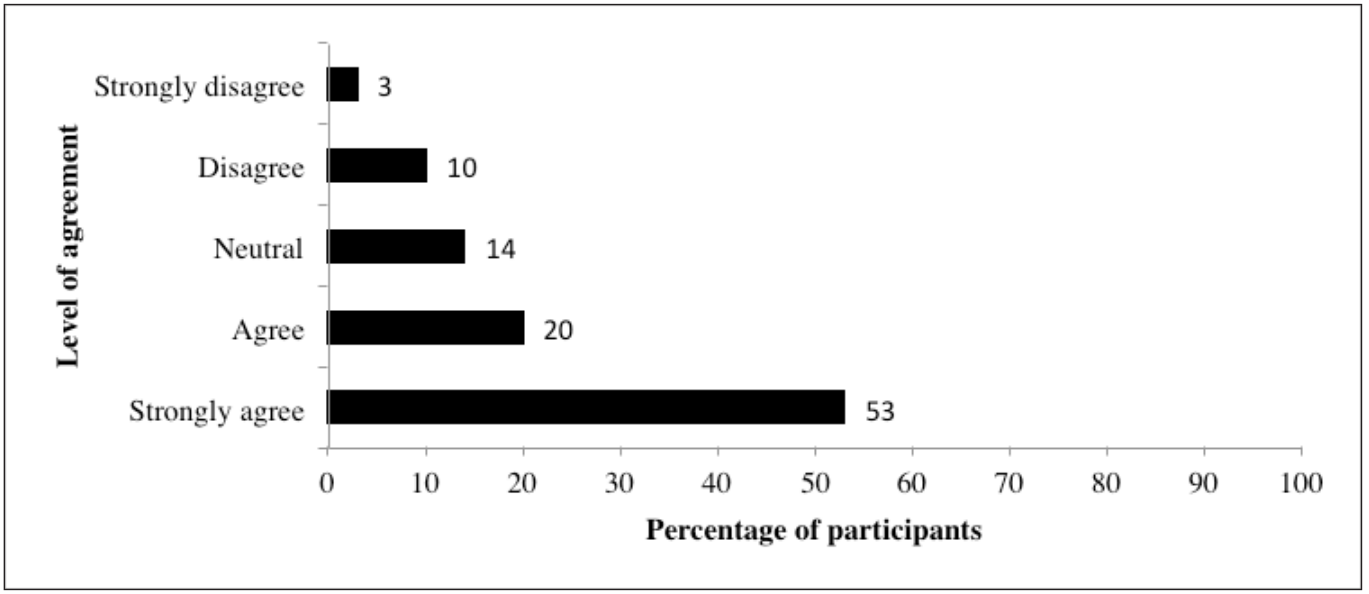

Figure 2. Participant level of agreement with the Meadows et al. definition

human subsystems, in order to be sustainable, must function within the limits of what nature can provide, now and into the future. The authors posit that this cohort has a deeper appreciation of ecosystem services and systems relationships, and recognizes that all forms of social organization that satisfy basic sustainability criteria must honor certain fundamental ecocultural relationships and constraints.

Prior to diving further into the workshop and providing background on current sustainability issues as related to LfS core competencies, one more poll was administered to pre-assess group opinions on the existing core competencies research literature. The workshop participants were asked: "Based on my current understanding of the literature on sustainability core competencies, I [blank] that it is robust enough to address academic curriculum and program development." The fill-in-the-blank options and division of votes are displayed in Figure 5. A total of 67 participants responded to this poll. The largest group of participants (48%) did not have a strong opinion regarding the potential of existing research on sustainability core competencies to support curriculum and program development. Based on the structuring of the question, however, it cannot be ascertained whether this is due to a simple lack of opinion on the matter, a belief that this area is neither well-developed nor poorly developed, or a lack of prior knowledge on core competency research. Only 22 percent of respondents believed that the existing core competency literature is robust enough, which may have been why many participants chose to attend the workshop.

Following the assessments, author Harold Glasser advocated for the development of relevant core competencies as a critical stepping stone

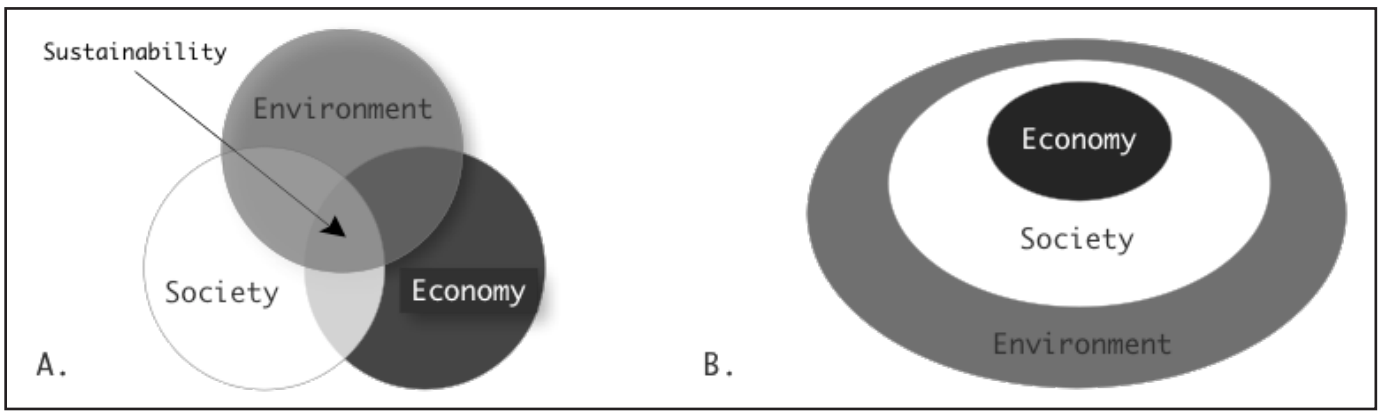

Figure 3. Visualizations of the relationships among economy, society, and the environment using two sustainability lenses

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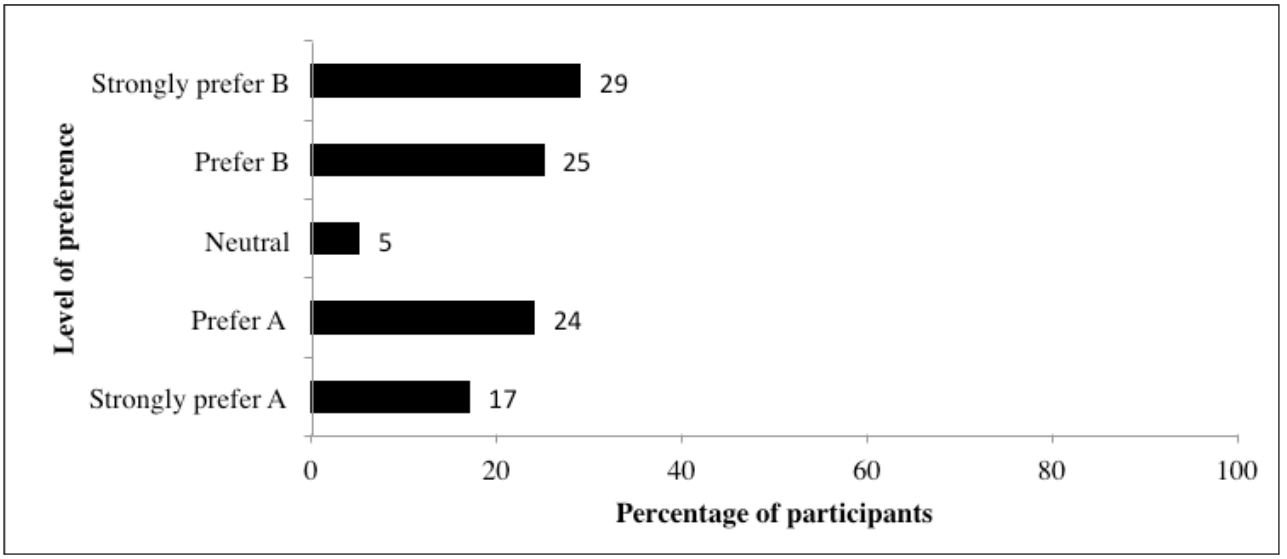

Figure 4. Participant level of agreement with each sustainability diagram

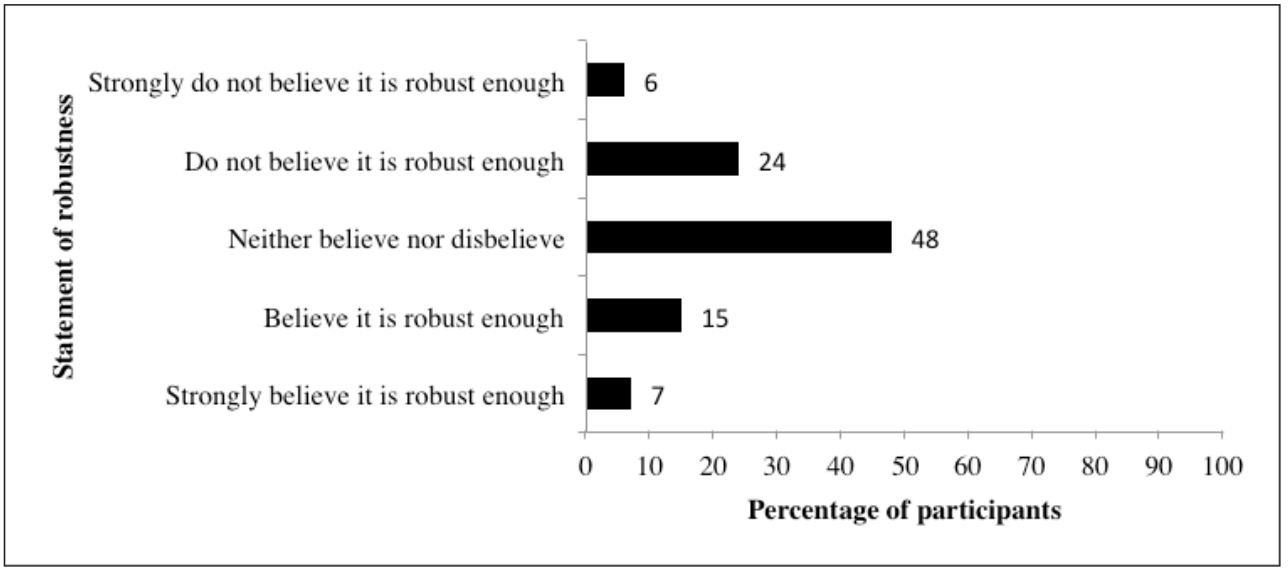

Figure 5. Pre-assessment of participants' opinion on the robustness of existing core competency research to support curriculum and program development

toward a life-affirming system of formal education, facilitated by a close examination of the current state of the planet. The sustainability vision advanced by Glasser was one in which sustainability, at its fundamental core, is about improving quality of life for all—now and into the future—while adapting human activity to fit what nature can provide. Realizing this sustainability vision is impeded by a "perception gap" within higher education and among the larger population as a whole. More specifically, this gap involves a general failure to perceive the schism between widespread stated values and aspirations to realize a more sustainable world and the world we have created and continue to perpetuate as a result of unsustainable practices, lifestyles, policies, and institutions that reproduce the status quo.

Thus, the bigger challenge becomes how to make the unsustainable, spatially and temporally separated consequences resulting from our daily actions (especially those in economically rich countries) more visible and directly felt. In order to bridge this gap, we need to learn how to model the sustainable behaviors we want to see in all citizens of the world, especially within the higher education system. Current higher education systems tend to foster the generation of data, information, and knowledge, but this type of learning alone is not likely to engender meaningful behavioral change. The

existing, decontextualized formal education system is built on creating first-order change, essentially doing more or less of different forms of what we are already doing. However, in order to engender deep meaning and a contextualized understanding of the interconnected sustainability challenges facing humanity, second-order change must also be enacted. In this case, second-order change requires transformative system structure changes, which entail reimagining formal education so that it creates a robust foundation for improving quality of life for all. This will involve a careful and critical look at the three primary components of formal education: content (what we teach), pedagogy (how we teach what we teach), and context (how we model our values, commitments, and aspirations in everything that we do—including, but not limited to operations, investment policies, purchasing, setting research priorities, tenure and promotion procedures, allocating budgets, and collaboration with the community).

Glasser ended this session with a discussion of the distinctions among capacities, capabilities, and competencies and an explanation of why these distinctions are significant for re-designing formal education systems to grow future sustainability leaders and change agents. Table 1 depicts the definitions he created to help participants understand these distinctions. At the end of this session, the table groups were given 45 minutes to develop their own provisional list of inclusive and encompassing sustainability competencies.

During the breakout session, the 10 table groups were immersed in discussion and sharing of personal experience. A scribe took notes at each table. These were then converted into a final list of competencies, which were submitted to the workshop facilitators. Many of the proposed competencies were suggested by multiple groups, as can be seen in Figure 6. It is important to note that while many groups used similar language or even identical terms to name a given competency, the participants may not have meant the same thing by these terms. Deep clarification of the meanings of the competencies, (or sub-competencies) and their constituents, as well as identification of promising pedagogies for facilitating their learning remain ongoing tasks for evidence-based research and practice.

Table 1. Definitions related to competency development

Term	Definition
Capacity	Having the requisite potential to understand, experience, or do something. (Capacities are latent and often unrealized.)
Capability	A talent or ability that is developed to some extent, has the potential for use, and may have the potential to be developed further.
Competency	A constellation of abilities, attitudes, knowledge, understanding, skills, and habits of mind that are functionally linked to support both problem- posing and problem-solving and evoke purposeful behavior toward particular end goals.
Sustainability	Particular competencies that are characterized by the unique role they play in addressing the sustainability challenges and opportunities that are before humanity.
Sustainability Core Competencies	A minimal set of complete but relatively non-overlapping competencies that are necessary and well-suited to support the form of transformative system structure changes, which are required to improve quality of life for all.

In addition to the 14 competencies shown in Figure 6, there were 27 other competencies proposed that were not echoed across multiple groups. Some groups proposed a smaller number of broader competencies, while other groups constructed very detailed lists of competencies and sub-competencies without regard to possible overlap. Some groups emphasized competence in social skills such as charisma, the ability to make personal connections, and communication, while others stressed unique skills such as creativity and resilience. There were groups that highlighted competencies more focused on supporting a shift to sustainable economies, connecting theory to practice, distinguishing between needs and drives, appreciating multiple senses of value beyond economic value (such as happiness, compassion, beauty, and ecological integrity), as well as those that proposed competencies in understanding motivation and behavior.

Following the breakout session, Glasser discussed the trajectory of nearly two decades of core competency research, while other workshop facilitators reviewed the competency lists proposed by each group. The discussion on core com-

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petencies research focused on the distinction between different methodological streams in the research. As a whole, much of the research has been drawn from expert opinion, stemming from either personal knowledge, information gained from surveys, or through workshops. This literature has generally asserted "laundry lists" of competencies. Many of these competencies are likely appropriate and very important, but they typically appear as broad-brush labels that cry out for substantial definitional detail. How these competency labels apply to curriculum and program development, in a generic and comprehensive sense, is far from clear. Furthermore, the importance of integrating these competencies into formal education is rarely developed in context. These competencies are generally not drawn back to a rich and robust understanding of the current state of the planet[14,15,17,20] and their essential role in fostering transformative individual and collective change that underpins improving quality of life for all is not made transparent. This grouping of literature, which tends to focus on educational reforms, will be referred to as Stream I.

There is also a small subset of this literature, which Glasser refers to as Stream II, that focuses on issues such as: reimagining formal education and transformative, second-order change; how the biophysical world works (and how humanity shapes it and it, in turn, re-shapes humanity); understanding the upstream and downstream consequences of production and consumption; the basis of human flourishing and the foundations for sustainable well-being societies; systems connections and feedback; social learning (including how our neurobiology influences how and what we learn, how we learn as a species, and how different cultures and individuals learn differently); affinity for all life; wise decision making; and modeling of sustainable behaviors and lifestyles (being the change we seek).[21-30]

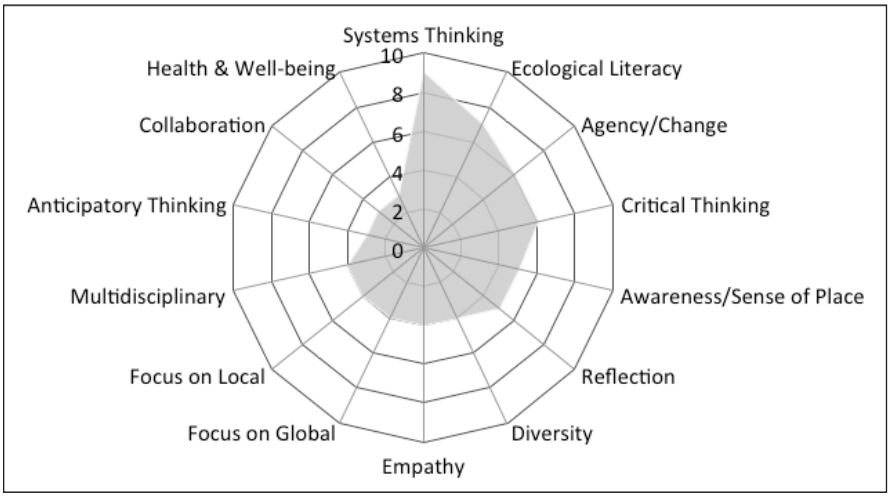

Figure 6. Popular competencies identified by multiple groups, by the number of groups that identified them

For example, Wiek, Withycombe, and Redman[31] discussed shortcomings with the existing core competencies literature, in particular the lack of a well-developed and thoroughly vetted set of core sustainability competencies that can serve as a guide for program and course development, faculty and staff training, evaluation, and research on both the effects of developing these competencies on behavior and continuous improvement of them. These authors made a major contribution by reviewing, organizing, and synthesizing the existing core competencies literature into a coherent framework of five key competencies: systems thinking, anticipatory, normative, strategic, and interpersonal. In addition to these labels, they also provided definitions and justifications, and discussed links to the other competencies. Additional work remains to develop the definitions into extended, rich descriptions with evaluatable learning outcomes that can serve as the foundation for curricular and program development, which is up to the task of supporting transformative change in formal education. This important research will be identified as the "left bank" of Stream II because it asks many of the most critical questions, but—as will be discussed later—it stops just short of wading into the depths to characterize a complete set of learning for sustainability competencies that can serve as a robust counterforce to the metanarrative that guides the status quo.

Table 2 depicts the basic distinction between these two main streams of thought. It is interesting to note that the sustainability competencies initially outlined by the workshop groups fall mostly between the centers of Stream I and Stream II. There are also other aspects of the literature that fall somewhere in between the two streams. Frisk and Larson[32] emphasized the importance of integrating sustainability knowledge, pedagogy, and understanding of behavioral change techniques. While this is a better framework for foster-

Table 2. Conceptualization of two streams of core competencies research

	Stream 1	(Inbetween)	Stream 2
Academic Orientation	Traditional Western Academic Model—with an emphasis on "reform"; disciplinary & interdisciplinary; focuses on getting the "content" right		Re-imagination of formal education; transdisciplinary; real-world problem solving focus; focuse on getting content, pedagogy, and modeling right
View of Quality of Life	Emphasis on improving standard of living for humans, which, by necessity, yields increased happiness		Emphasis on advancing the common good; holistic; systems-based; appreciation of ecosystems services, biological and cultural diversity, peace, security, social justice, equity, resilience, precaution, and restraint
Perspective	Decontextualized; local; short-term (5 - 10 yr temporal orientation)		Context specific—the current state of the planet and how we got here; multiple scales—local to global; present and future generations (distant future)
View of Nature	Instrumental; anthropocentric; some form of substitution can always be found for Nature's services		Reflects both use- and non-use values; nonanthropocentric considerations; reflects limits to exploitation of nature and substitution; identifies with all life and the flourishing of nonhumans
Perspective on Economic Growth	Economic growth is good and grounded in technological advancement; Enlightment notion of progress—social progress is hitched to economic and technological progress		Asks: "What kind of growth?" "What is growth for?" "Who benefits and loses?" "What are the costs of growth?" "How long can the growth be maintained?" etc.; embraces limits
Approach to Decision Making	People make bad decisions because they don't have proper or enough information (rational actor model), are in denial, or are hypocritical; correct and readily accessible information is the key to improved decision making		People make bad decisions because they are human—they face with conflicting objectives, multiple priorities, a complex neurobiology, maladaptive modeling, arrogance, overconfidence, denial, and incomplete information; government intervention is key to improved decision making
Approach to Learning	Single-loop learning; learning for getting a job; grounded in formal education and individual learning; problem-solving orientation		Single-, double-loop learning, grounded in advancing social, non-formal, and informal learning; problem posing is as important as problem-solving and key to it; many of the problems we face are "wicked" and never truly "solved"—experimentation, feedback, revision, and iteration are central to living with them
Approach to Change	First-order change; 5 - 10 year temporal orientation; ad hoc and adaptive		Systems structure matters; sometimes second-order, transformative change is needed; temporal orientation reflects multiple generations (distant future); anticipatory

ing long-term, meaningful change, the conceptualization of necessary behavioral concepts is limited to thoughts and attitudes, not objective behavioral that can be overtly seen and measured.

Both Rieckmann[33] and Wiek[34] have engaged scholars and experts around the world to survey opinions on core competencies for sustainability. Rieckmann was able to achieve some consensus from respondents regarding big-idea, overarching competency titles (e.g., normative, strategic thinking skills), but did not flesh out the details of these big ideas. Wiek[34] asked 31 North American and European academic sustainability experts, "What do you consider to be core competencies in sustainability (title, definition, justification)?" and mapped the survey responses into the five key competencies outlined by Wiek et al.[31]—systems thinking, anticipatory, normative, strategic, and interpersonal. While the respondents provided some salient and suggestive catch phrases, many of which could be mapped into the Wiek et al.[31] key competencies, overall, much of what they offered was a hodgepodge that was frequently tautological in nature, leaving considerable ambiguity, or at least not enough clarity to foster curriculum with learning outcomes around such ideas. Nonetheless, the authors believe that the five key competencies proposed and developed by Wiek et al. do provide a sufficient and promising foundation from which to develop complimentary, more robust, detailed, and contextualized competencies.

During the workshop, the authors argued that there are still major gaps in the literature. Researchers and scholars appear to be aware of the many problems that plague our world, but many of the proposed solutions are piecemeal and not sufficiently in line with the scope of the problem. Additionally, many proposed solutions do not leverage the potential of learning to facilitate transformative, species-scale, system-structure change. And these solutions don't seem to address the challenges associated with catalyzing radical changes to formal education. The authors believe that in order to create meaningful, long-term solutions, the appropriate questions must first be asked. Central to this effort is training researchers to have a robust understanding of the problem space and to effectively align this with the relevant and appropriate solution space. Thus, prior to the meeting, Glasser put forth his own,

very tentative, conceptualization of overarching categories of core competencies, and the necessary constituents (sub-elements) that he believes are imperative for any efforts toward program and curriculum development. These competencies are to be considered in addition to those proposed by Wiek et al.,[31] though there is likely a small amount of concept overlap. The framework for the Glasser competencies is presented in Table 3.

Following this broad-brush review of the sustainability core competencies literature, workshop participants were given additional time with their table groups to reflect on and refine the competencies they outlined initially in light of the workshop facilitators' discussion of the two streams.

In order to understand the impact of the information presented at the workshop, participants also engaged in a series of polls at the conclusion of the workshop. Participants were asked to rate their level of agreement with the five key competencies presented by Wiek et al.[31] and the additional five overarching competencies proposed by Glasser during the workshop (shown in Figure 7). Voting was based on participants' holistic understanding of the competency titles and the descriptive constituents as presented by the facilitators. Neutral responses were eliminated and the data was normalized to reflect only levels of agreement or disagreement.

It should be noted that participants' level of agreement with the competencies could have been influenced by their lack of agreement with (or understanding of) the overarching competency title, the descriptive constituents, or some combination of the two. In regard to the Wiek et al. competencies,[31] participants most agreed with the systems thinking competency (91%); the next highest-rated competency was interpersonal (73%). There was greater agreement amongst all Glasser competencies (between 67% and 91%) than those proposed by Wiek et al. (agreement

Table 3. Glasser's proposed competencies and constituents

Affinity for All Life	State of the Planet Knowledge	Wise Decision Making	Modeling Sustainable Behavior	Transformative Social Change
Identification with all life	Deep understanding of how nature sustains life	Ability to detect error and illusion	Being the change one wants to see in the world (Gandhi)	Social learning for sustainability leadership and collaboration
Biophilia integration	Understanding current, widely-held state of the planet perceptions and their limits	Ability to embrace multiple perspectives and organize knowledge in context	Incorporating deep understanding of the state of the planet into policies and actions	Recognition of motivational variables and consequences of action
Species-level humility	Understanding of climate change	Ability to tolerate ambiguity	Acting in accordance with long-term goals	Ability to make the invisible visible
Understanding of how life on planet Earth coevolved	Understanding of environmental carrying capacity limits	Appreciation of multiple objectives and human problem-solving limits	Responding to maladaptive forces effectively	Ability to recognize the significance of 1st- and 2nd-order change
Cultural diversity appreciation	Understanding of biological and cultural diversity loss rates	Ability to maintain hope in the face of tremendous challenges	Acting in ways that maintain and build resilience	Ability to apply 1st-and 2nd-order change strategies appropriately
Biological diversity appreciation	Facility to foster state of the planet knowledge recalibration	Ability to put risk and uncertainty into perspective	Creating policy incentives to encourage the behavior we seek	Facility to inspire collective change for sustainability
Appreciation for the magic and wonder of life on planet Earth	Understanding linear and nonlinear growth rates and consequences	Ability to check overconfidence and suspend judgment	Prioritizing high-level values when tradeoffs arise	Openness to the views and concerns of others
		Ability to detect maladaptation and respond to it		Facility to perform action research

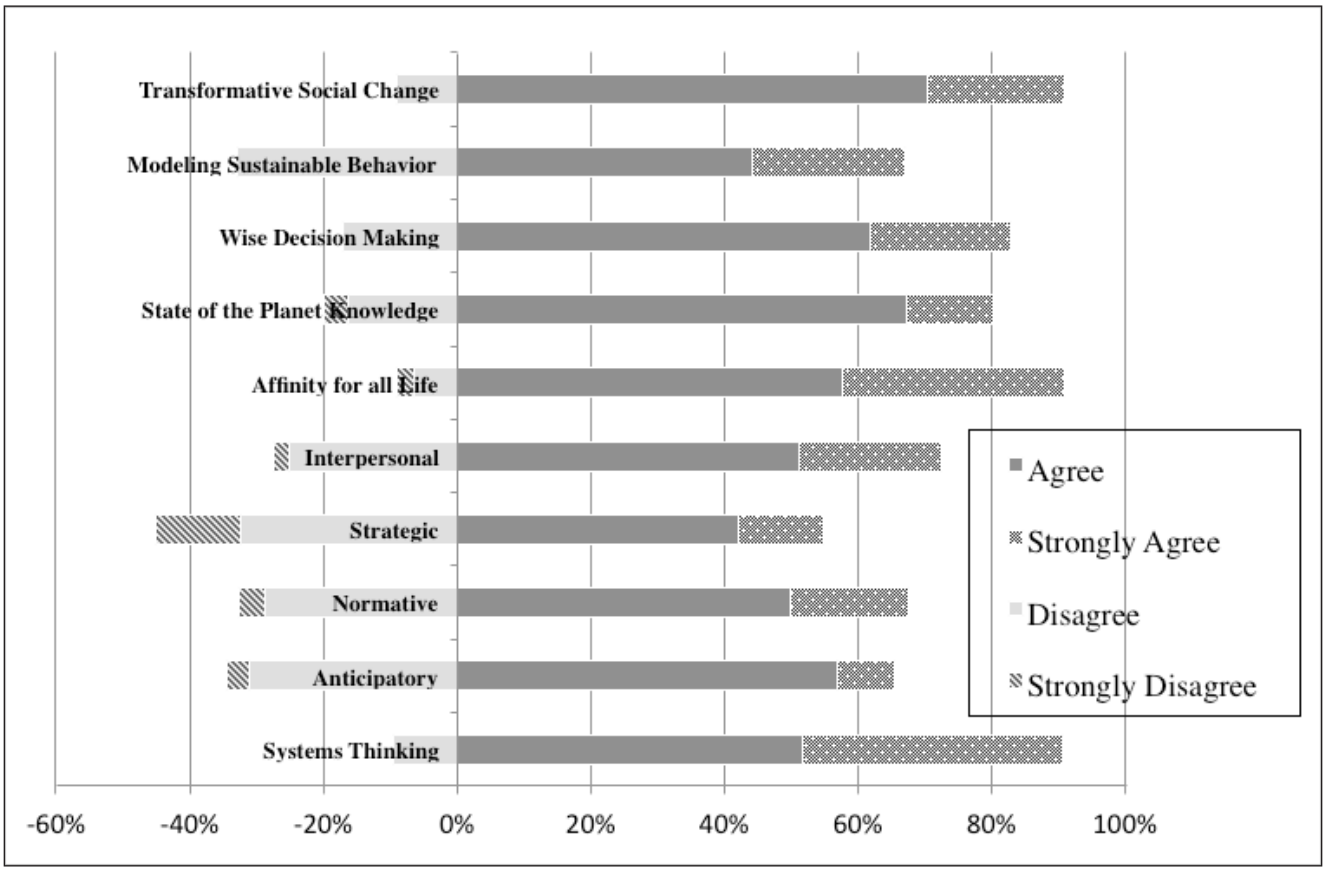

Figure 7. Level of participant agreement with the 10 core competencies discussed

falling between 55% and 91%). Four of the Glasser proposed competencies received at least 80 percent agreement (affinity for all life, state of the planet knowledge, wise decision making, transformative social change). Additionally, the Glasser-proposed competencies generally met with lower levels of disagreement. The average level of disagreement for the Glasser competencies was 18 percent, whereas the average level of disagreement with the Wiek et al. competencies was 30 percent. It is important to note that these results might have been an artifact of the workshop structure, which allowed participants to ask clarifying questions to the facilitators.

In addition to these basic findings, more thought-provoking analysis can be derived from the levels of agreement and disagreement with certain competencies. Attendees were instructed to vote on their agreement with a competency with respect to the competency package presented, that is, both the broad title and the more explanatory constituents that comprised it. Thus, if attendees disagreed strongly with one descriptive constituent, they were told to vote in disagreement with that competency as a whole. This may have accounted for higher rates of disagreement across all competencies.

With regard to the competencies by Wiek et al., it was not surprising that there was a very high level of agreement with respect to systems thinking, given that this competency was put forth independently by nine out of the 10 workshop groups in their initial competency lists. Votes for the anticipatory competency had the second-lowest level of overall agreement (66%). It is worth noting that three groups proposed a competency, "anticipatory thinking," relatable to the Wiek et al. anticipatory competency. The Wiek et al. strategic competency, which was the lowest rated, had a low level of strong agreement 13% and the highest level of overall disagreement (45%) as well as the highest level of strong disagreement, over three times that of the next highest, at 13%. With regard to the competencies put forth by Glasser, state of planet knowledge had a high level of agreement (67%), but a higher level of disagreement (16%) than strong agreement (13%). The relatively significant level of disagreement with this competency is interesting considering it subsumes ecological literacy, which was identified by seven out of the 10 workshop groups. One of the most

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noteworthy findings is related to the modeling sustainable behavior competency. This competency had a high level of strong agreement (the third highest of all 10 competencies), but the fourth highest level of disagreement of all 10 competencies assessed (although it was tied for the third-highest level of overall disagreement because it received no strong disagreement votes).

In reviewing the Glasser competencies, the authors considered modeling sustainable behavior and transformative social change to go hand-and-hand—that is, emphasizing the importance of being mindful of individual behavior in relation to changing the behavior of others on a larger social scale. Thus, the data is somewhat perplexing with respect to modeling sustainable behavior given the high rate of strong agreement and high rate of disagreement, especially since transformative social change had the highest level of agreement of all competencies. It is possible that some workshop participants had a conceptually different understanding of the role of modeling (interpreted as developing or using abstract mathematical models as opposed to the authors' intended meaning as demonstrating or exemplifying sustainable behaviors and lifestyles) and its potential impact on both small- and large-scale change. Social learning theory[35] developed following years of research supporting the concept that much of behavior is learned through observation of others' behavior. It is possible that these findings mimic the general lack of action among most of the world's human inhabitants and the gap that persists between stated values and actual behavior. [28]

The participants were also asked to rate the extent to which they felt the competencies their groups' developed matched up with the 10 competencies identified by Wiek et al.[31] and those discussed by the authors. Since the competencies proposed by Wiek et al. and those put forth by Glasser were open to individual interpretation, it was important to assess whether workshop participants both saw their own competencies reflected in the 10 presented competencies and felt that the 10 presented competencies adequately covered the terrain that they saw as relevant. Additionally, this data made basic analysis somewhat easier for the authors given that many competencies proposed by workshop participants were only a word or two, and as a result, incorporated substantial in-built methodological vagueness. The results of this poll are shown in Figure 8.

Figure 8 suggests that while the participants believe that there is significant overlap among the 10 presented competencies and their own, it also indicates that the they believe that they identified some significant competencies that were not covered by either Wiek et al. or Glasser. All of these results suggest that much work

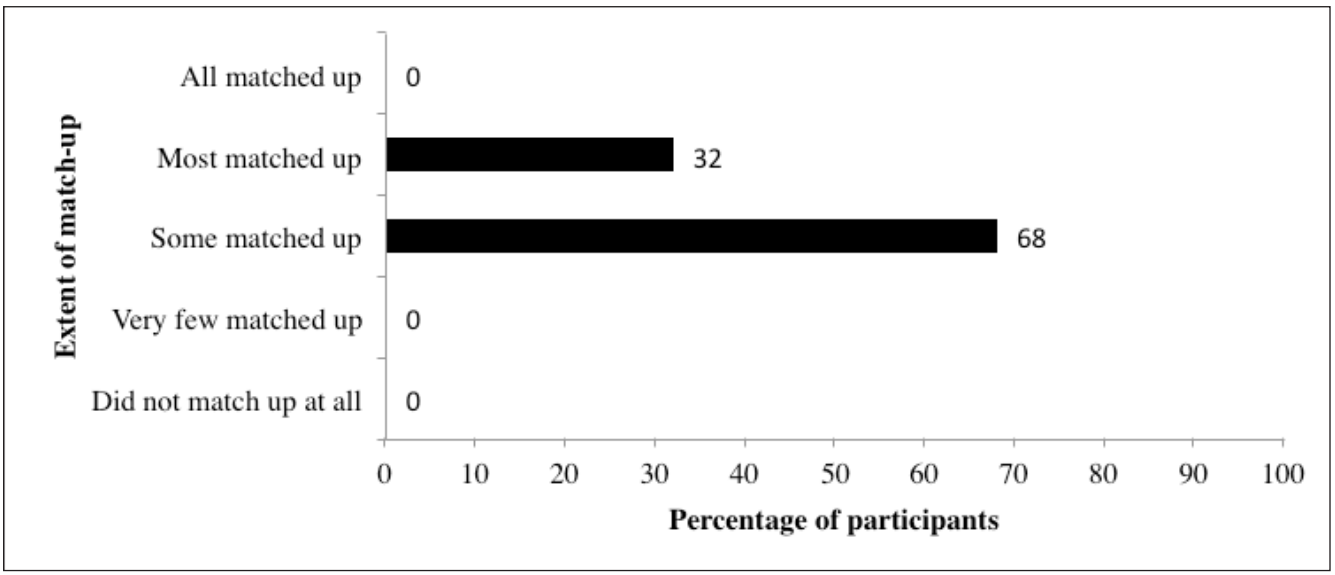

Figure 8. Extent to which participants believed the competencies they created matched those proposed by Wiek et al.[31] and Glasser

still needs to be done to develop and refine a complete and minimal set of relatively non-overlapping key or core sustainability competencies.

The final poll functioned as a post-assessment, asking participants again whether they believed that the existing core competencies literature provides sufficient direction for academic curriculum and program development. This poll, shown in Figure 9, was used to generate information regarding whether participant opinions changed following the workshop presentations and discussion and is closely related to the question that was assessed in Figure 5. While the question was phrased somewhat differently (i.e., "I believe that the current literature on Sustainability Core Competencies provides [blank] direction for academic curriculum and program development."), it assessed the same basic information. These post-assessment results suggest that while about the same percent of participants (roughly 50%) believed that the existing literature provides adequate support for curriculum and program development, there was a substantial decrease in the percent of participants that thought the literature provides little direction (24% originally) and a substantial increase in the percent of participants who believed it provides considerable direction (originally 15%). While it's difficult to speak with certainty, since the questions were posed slightly differently, these results suggest that participation in the workshop enhanced the participants' outlook on the efficacy of the sustainability core competencies literature to support curriculum and program development.

Conclusion

Along with the new, burgeoning emphasis on transformative change to support sustainable well-being societies, there has also been corresponding rapid growth in the global literature on education for sustainable development (ESD) and learning for sustainability (LfS) competencies. Despite some notable achievements, a few of which were discussed in this article, this literature is adrift in a sea of labels, pregnant with possibility, but lacking consensus as to what constitutes a minimal but comprehensive and relatively non-overlapping set of ESD/LfS core competencies. There does appear to be a lot of common ground, but only at a very abstract level. Beyond a few of these core competencies (systems and anticipatory thinking, for instance) little work has been done to delineate what constitutes broadly acceptable, detailed descriptions of these ESD/LfS core competencies that can provide suitable guidance for program and curriculum development or major re-organization of academic institutions. A noteworthy exception, is the recent book chapter by Wiek, Bernstein, Foley, et al., which makes an important contribution towards this effort to operationalize sustainability core competencies. [36]

While this workshop served as a small step toward the development of evidence-based LfS core competencies, there is still much research

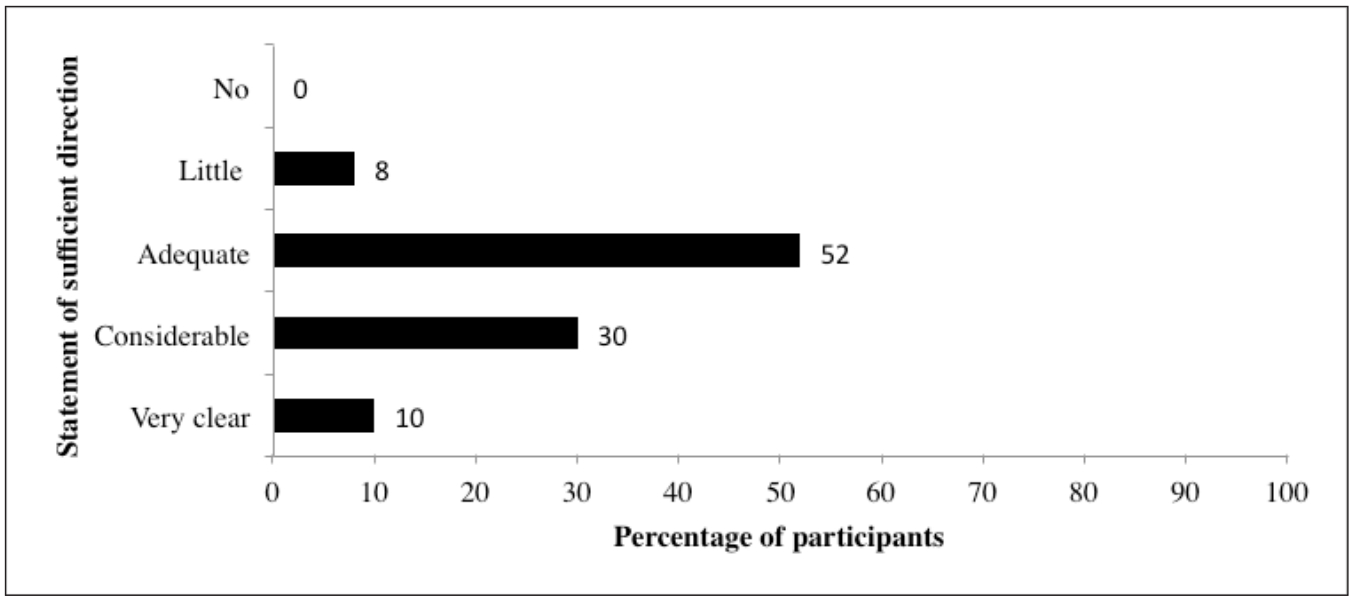

Figure 9. Post-assessment of participants' opinion on the extent of direction that existing core competency literature provides to support curriculum and program development

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and experimentation to be done. In short, further work must be initiated to identify and characterize: what constitutes a minimal but comprehensive and relatively non-overlapping set of ESD/LfS core competencies, high-leverage pedagogies to stimulate their acquisition, and assessment procedures that are appropriate for evaluating competency acquisition. Taking on these challenges by an exceptionally qualified team of international researchers, with great sensitivity to cultural diversity, is foundational to meeting the calls by the UN, UNESCO, and others for a paradigm shift in education and learning that can usher in a sustainable and desirable future for all.

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