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Educating for Sustainability: Competencies & Practices for Transformative Action

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Abstract

Achieving a sustainable future requires that individuals adopt different values, attitudes, habits, and behaviors, which are often learned and cemented at a young age. Unfortunately, current educational efforts are inadequate for achieving transformative action. Even programs whose primary goal is to promote responsible, pro-environmental behaviors have largely failed at creating change among students. The lack of efficacy in sustainability-related educational programs is at least partly due to faulty assumptions about knowledge automatically leading to action, and by extension, the information-intensive methods that focus largely on declarative knowledge regarding how environmental systems work. Meanwhile, social science literature clearly highlights the need to go beyond ecological and technical knowledge when educating for transformative action, since sustainable behaviors are motivated by much more than declarative information. In order to effectively educate for sustainability, alternative forms of knowledge (i.e., procedural, effectiveness, and social knowledge) are essential, as is the consideration of various barriers and motivators for action. The transition towards sustainability will require action and change that is guided by an understanding of the complexities that arise within an interconnected system, as well as the ability to collaborate with people from diverse backgrounds, while keeping an eye to the future. In formulating our approach to educating for sustainability, we incorporate perspectives from three somewhat disparate fields: (i) behavioral change research, (ii) sustainability scholarship, and (iii) educational pedagogy. While drawing upon diverse knowledge domains, our primary purpose is to integrate behavior change research and sustainability competencies in developing effective educational approaches for transformative actions.

Key Words: sustainability education; sustainability competencies; pedagogy; behavior change; transformative action; pro-environmental behavior

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Introduction

As the urgency to address environmental, social, and economic challenges increases worldwide, education continues to be seen as a central part of the solutions for sustainability (Sterling, 2001, UNESCO, 1997). In 1997, UNESCO issued a report declaring: "education is the most effective means that society possesses for confronting the challenges of the future. Indeed, education will shape the world of tomorrow" (UNESCO, 1997, pp. 17). The UNESCO report goes on to argue that education should play a pivotal role in bringing about the deep change required to move towards sustainability (UNESCO, 1997). With a focus on educating for sustainability and transformative action, this paper aims to establish effective educational practices needed to achieve key competencies and the behavioral changes required to attain a sustainable future.

While many scholars and practitioners are relying on education to lead us towards sustainability (Rowe, 2007; Sterling, 2001; UNESCO 1997), our current education system may be doing the opposite. In particular, schools tend to teach competition through didactic teaching methods focused on individual products and high-stakes testing, as opposed to focusing on collective solutions for the challenging social and environmental problems we face (Sterling, 2001). These traditional methods of lecture and assessment tend to over-simplify complex issues and trade-offs into right or wrong answers, while emphasizing individual achievement over group collaboration. In dealing with challenges of the 21st century, we cannot perpetuate the thinking and educational practices of the past (Nolet, 2009; Sterling, 2001). Instead, we must envision a new education system capable of addressing modern environmental and societal challenges in all their complexity. As Orr (1991) notes, it is only education of a "certain kind" that will save us, progress us, or advance us towards sustainability.

The dominant philosophical approach of many environmental education programs can be summarized in a statement by ecologist Babia Dioum Senegalese: "In the end, we will conserve only what we love. We only love what we understand. We only understand what we are taught**"** (Purrenhage, 2010; Donahue, 2008, K-12 and Community Programs section). Or, in the words of Jane Goodall: "Only if we understand can we care. Only if we care will we help. Only if we help shall we be saved" (Rimington, 2010, Excerpt from Speech section). Implicit in these inspirational quotes is the notion that knowledge leads to behavior change and environmentally favorable action, which is in fact the ultimate goal of most environmental education programs (Simmons, 1991). In spite of this worthy goal, substantial research illustrates how programs have failed to achieve transformative change (Ramsey, 1993).

Standard knowledge-based educational approaches to behavior change have a disappointing track record (Finger, 2010; Nolet, 2009; Stern, 2000). The failure of environmental education to broadly change individual behaviors and collective action is primarily due to unsubstantiated assumptions about the relationship between knowledge and behavior (Finger, 2010; Simmons & Volk, 2002; McKenzie-Mohr, 2000; Ramsey, 1993). The quotes from Senegalese and Goodall imply that understanding an issue or problem is a causal factor for concern, and ultimately, behavior change. As Dr. Harold Hungerford, a well-respected environmental educator, stated: "[Environmental educators] still believe—so very strongly—in the knowledge>attitude>behavior model of learning when, at the same time, we know how desperately inadequate this is when it comes to changing the citizenship behaviors of large numbers of learners over long periods of time" (Simmons & Volk, 2002, p. 7).

Although the literature unequivocally points to a lack of success in information-based approaches to behavioral change (Finger, 2010; Leiserowitz, et al., 2005; Barr, 2002; Trumbo & O'Keefe, 2001; McKenzie-Mohr, 2000; Stern, 2000), educators still cling to the outdated mantra that more knowledge will spur transformative action (Simmons & Volk, 2002; Sterling, 2001; Senge, 2000). The failure to incorporate behavioral sciences into educational philosophies and practice has resulted in

a fundamental inability to promote transformative action, despite the fact that behavior change is often a stated goal of educational programs. Through the integration of knowledge domains that speak to ecological knowledge as well as social norms, beliefs about behaviors, and how-to information about specific problems and actions, we aim to develop an educational approach that resonates with behavioral science and core competencies for sustainability.

To further educational efforts for transformative action, we integrate three critical yet mostly disparate bodies of literature—behavioral research, sustainability competencies, and education pedagogy (Figure 1). First, we review the role of varying types of knowledge, information, and education in changing behaviors, in addition to broader theoretical and empirical insights about what motivates and constrains environmental actions. Next, we integrate the educational and sustainability literature to illustrate how four competencies central to sustainability education can most effectively be achieved via particular teaching approaches, specifically focusing on transformative actions in the context of systems thinking, a future orientation, and collaborative decision making. We end by reflecting on critical challenges and opportunities for educational initiatives aimed at changing behaviors for sustainability. Our focus is on K-12 education since socially pervasive behaviors are highly resistant to change as they become engrained in adulthood (Leiserowitz, et al., 2005). However, these principles and practices are adaptable to many different age groups and social settings for learning.

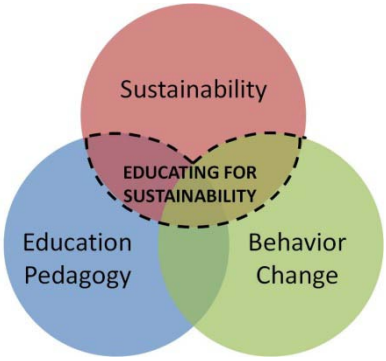

Figure 1. Integrating disparate fields for an interdisciplinary approach to sustainability education

Education and Behavioral Change Research

The centrality of behavioral sciences for achieving the goal of transformative action is often overlooked in educational philosophies and practice. Various theories and studies explain and examine human behavior and how best to motivate pro-environmental actions, yet this research has not been well integrated into educational practices. Although hundreds of studies have been done, no single theory fully captures why people act the way they do, largely because of the complexity of multifaceted human behaviors in diverse contexts (Kollmuss & Agyeman, 2002). Varying classes of pro-environmental behaviors—encompassing consumptive and political actions in both private and public spheres—ultimately have different motivators and barriers (Stern, 2000). Rather than offering an exhaustive review of the literature, we discuss prominent behavioral theories and related studies in order to inform the relationship between education and action while considering four different domains of knowledge: declarative, procedural, effectiveness, and social knowledge (Kaiser & Fuhrer 2003). While insufficient individually in explaining the motivations behind people's actions, these knowledge domains collectively provide an overarching framework for synthesizing various schools of thought in the behavioral sciences, especially in linking predictors of behavior to effective educational approaches for sustainability (Table 1).

Ecological or declarative knowledge typically addresses how environmental systems operate in technical, mechanical or biophysical terms, as with information about the ecological structure and functioning of ecosystems (Kaiser & Fuhrer, 2003). Although the least effective in promoting pro-environmental behaviors, declarative knowledge has been the central focus of most educational programs (Simmons & Volk, 2002; Pooley & O'Connor, 2000). Declarative knowledge is emphasized in the Information-Deficit Model (IDM) developed by behavioral scientists in the early 1970s (Kollmuss & Agyeman, 2002). In a straightforward, linear fashion, this model claims that environmental knowledge leads to awareness and concern, and ultimately, to pro-environmental behaviors. Psychologists and others have refuted this simplistic assumption, noting that changing behavior is very difficult and information is simply not enough to spur change (Kollmus & Agyeman, 2002). While declarative knowledge often does not appear to directly motivate behaviors, the lack of such knowledge may form a barrier to changing behaviors (Monroe, 2003). For example, declarative knowledge about drought conditions or where water comes from is not likely to motivate water conservation behaviors. However, a lack of specific declarative knowledge—such as the water needs of plants—may lead people to over-irrigate low water-use species, as this information embodies procedural information about how much plants should be watered.

The second domain is procedural knowledge, which refers to basic how-to information such as how to sort garbage into recyclables and non-recyclables for proper disposal (Kaiser & Fuhrer, 2003; Monroe, 2003). Certain forms of procedural knowledge have been found to be more effective in promoting behavioral change; for instance, information about how to participate in decision-making processes is a strong predictor of political engagement (Kaiser & Fuhrer, 2003). Procedural information provides answers to questions such as 'where do I vote?' or 'how do I register?,' but not value-laden questions such as 'what is the significance of my vote?' Procedural knowledge correlates closely with broader situational and structural factors that facilitate or constrain action, since people's awareness of infrastructure or incentives that support or limit behaviors is crucial for taking advantage of opportunities or overcoming obstacles to action. This type of knowledge is especially crucial for developing an understanding of the strategies that can be taken under a set of circumstances, but it tends to be most effective when coupled with effectiveness and social knowledge.

Effectiveness, or impact, knowledge addresses the outcomes of different behaviors, essentially answering the question 'is the behavioral sacrifice worthwhile?' (Kaiser & Fuhrer, 2003; Monroe, 2003). Stern's (2000) Value-Belief-Norm (VBN) model of pro-ecological behavior highlights two key determinants pertinent to effectiveness knowledge; the first is the perceived consequences of behaviors, and the second is beliefs about who is responsible for environmental outcomes. The latter correlates to a person's "locus of control," which represents the confidence individuals have in their ability to bring about impactful change through their personal actions (Kollmuss & Agyeman, 2002; Monroe, 2003, Hines et al., 1986). Effectiveness knowledge influences behaviors through people's perceptions about how their behaviors impact the environment. As such, they are closely correlated to subjective values, beliefs, attitudes, and norms (Kaiser & Fuhrer, 2003; Monroe, 2003). For example, if an individual believes that recycling is not a cost-effective or sustainable means of waste management, their negative attitudes may deter them from recycling. While educating people about how their actions impact the environment or society is worthwhile, practitioners must recognize that people often selectively acquire and process information to match their values, beliefs, or behaviors (Kollmuss & Agyeman 2002), thereby presenting potential barriers to behavior change. In particular, Cognitive Dissonance Theory (Festinger, 1957) explains that individuals rationalize inconsistencies in information in order to match their preexisting views or actions; therefore, people may not act upon new information if it diverges from or conflicts with preexisting knowledge, attitudes, or behaviors. Thus, people's understanding of

the impacts of their behaviors is crucial to consider, including factual knowledge as well as subjective beliefs about control, efficacy, and ultimately, the outcomes of particular actions.

Fourth, and finally, social knowledge encompasses information regarding the motives and intentions of other people (Kollmuss & Agyeman, 2002). Social knowledge embodies what is typically described as social norms by behavioral scientists (Trumbo & O'Keefe, 2001; Stern, 2000). Kaiser and Fuhrer (2003) use social knowledge to explain two types of norms; conventional norms refer to customs, traditions, and expectations associated with the need for social approval, while moral norms refer to the value or importance a person places on equity, human welfare, environmental impacts or other behavioral outcomes. Schultz et al. (2007) further distinguish between different types of norms; descriptive norms refer to perceptions of what is commonly done, whereas injunctive norms refer to what is approved or disapproved by others. Community-Based Social Marketing (CBSM) stresses the power of injunctive norms by applauding desirable behaviors and establishing positive views of people's ability to create change (McKenzie-Mohr, 2000). Such approaches represent the combined use of social and effectiveness knowledge, respectively, emphasizing the behavioral outcomes valued by society. Changing the perception of what society approves or views as desirable has been the subject of much research and marketing campaigns ranging from anti-smoking to recycling. The importance of social norms as a predictor of behavior is especially critical in a normative field such as sustainability, where societal values are central in guiding what we ought to sustain and how.

Many theories underscore the importance of social knowledge while highlighting the role of knowledge domains in changing behaviors, in addition to going beyond the technical approach emphasized in the failed Information Deficit Model (IDM) (see Table 1). For example, the Theories of Reasoned Action (TRA) (Fishbein and Ajzen 1975) and Planned Behavior (TPB) (Ajzen, 1985) both stress beliefs concerning behavioral consequences (effectiveness knowledge) as well as normative expectations of others (social knowledge), which are also emphasized by Stern's VBN Theory (2000). In recognizing a variety of predictors for behaviors in different settings, Community-Based Social Marketing (CBSM) fosters sustainable behaviors by employing a contextually rich, place-based approach to identifying and remedying specific barriers to desired actions (McKenzie-Mohr, 2000). Linking the predictors of behavior to diverse knowledge domains (Table 1) drives home the importance of incorporating an array of information into educational efforts, above and beyond the traditional reliance on declarative knowledge.

Table 1

Theoretical predictors of behavior in relation to knowledge domains

Knowledge Domains	**Predictor of Behavior (source theory*)**
Declarative: Understanding of how environmental systems function	Technical information (IDM) Awareness of environmental problems (IDM) Mechanical understanding of issues (IDM)
Procedural: Awareness of how to undertake particular actions	Process-oriented 'how to' information (IDM, MREB) Structural influences & limits (VBN, CBSM) Situational constraints & opportunities (VBN, CBSM)
Effectiveness: Views of the outcomes of different behaviors	Personal efficacy & locus of control (VBN, MREB, TRA, CBSM) Perceived consequences of actions (VNB) Attitudinal evaluations of outcome (TRA, TPB)

Social: Awareness of motives and intentions of other people or society	Ascribed responsibilities to self & others (MREB) Beliefs about social norms & expectations (TRA, TPB) Perceptions & pressures conveying what is dis/approved (CBSM)

*Information Deficit Model=IDM (Kollmuss & Agyeman, 2002), Value-Beliefs-Norms=VBN (Stern, 2000), Theory of Reasoned Action=TRA, Theory of Planned Behavior=TPB (Ajzen, 1985), Community-Based Social Marketing=CBSM (McKenzie-Mohr, 2000), Model of Responsible Environmental Behavior=MREB (Hines et al. 1986)

Insights from behavior change research can be integrated into educational practices in many ways. As Monroe (2003) explains in her review of behavioral research a successful educational program to promote the purchase of locally grown food would emphasize testimonials from people who buy and enjoy it (social knowledge), recipes and information about how to acquire it (procedural knowledge), and details on its easy availability, freshness, taste, and other positive impacts (effectiveness knowledge). The focus of such a program would not simply be based on knowledge about food miles, greenhouse gases, or other ecological aspects of food production (declarative knowledge), but instead would addresses barriers, intentions, beliefs, and social norms across knowledge domains. In short, sustainability education intended to spur action should take a systemic, multi-pronged approach to changing behaviors by incorporating multiple knowledge domains—including value-based judgments and beliefs—to motivate sustainable actions.

Sustainability Competencies and Reinforcing Educational Approaches

Sustainability does not refer to some static paradise, but rather, implies a capacity for human beings to continuously adapt to environmental and societal conditions (Scott, 2002). In other words, successful sustainability strategies are flexible, resilient, and responsive (Crow 2007). Similarly, the principles and practices developed for sustainability education should have a flexible, adaptable character to ensure their relevance in a variety of different settings. Building healthy, responsive educational systems requires that schools continuously learn and adapt, rather than press on with the out-dated education practices. Rather than simply meeting set standards and "checking off" that sustainability has been taught, the challenge lies in developing methods and actions through which students are effectively acquiring key competencies in support of sustainable actions (Sterling, 2001).

Competence-oriented education stresses student outputs, whereas traditional, didactic approaches in K-12 and higher education have centered on teacher inputs. The input approach is often related to standards for whether the teacher has covered the material pertaining to conceptual strands such as " The History and Nature of Science" (AZ Department of Education, 2005). In contrast, the output-oriented approach focuses on students gaining the "concepts and abilities for social action" (de Haan, 2006: 22). Taking an output-oriented approach herein, our sustainability "competencies" embody the concepts and skills that will enable students to understand and resolve complex sustainability problems by equipping them with the ability to become change agents (Wiek et al., 2011). In discussing educational approaches that reinforce the competencies, we emphasize pedagogy in terms of the teaching and learning methodologies and strategies that support the attainment of sustainability competencies (Segalas, et al., 2010; Sipos, et al., 2008).

A variety of projects have recently tried to reform schools so that they educate for sustainability. The *Washington Sustainable Design Project* was created to integrate sustainability throughout the state's K-12 schools, with the following key competencies: systems thinking, active engagement, cooperative group learning, and connection with communities and stakeholder perspectives (Wheeler, et al., 2008). A German sustainability program similarly highlights foresighted thinking, an interdisciplinary approach, and action-orientation as its core competencies (de Haan, 2006). Many of these same sustainability

competencies are reiterated elsewhere in the literature (UNESCO, n.d.; Church & Skelton, 2010; Sipos, et al., 2008; de Hann, 2006; Gruenewald, 2004). Yet little dialogue has developed on how best to convey these competencies so that students actually acquire them (Wiek, et al., 2011).

Drawing on previous work, we focus on four key sustainability competencies: (1) systems thinking and an understanding of interconnectedness (Garrett & Roberson, 2008), (2) long-term, foresighted reasoning and strategizing (Pepper & Wildy, 2008; MacKay & McKiernan, 2004), (3) stakeholder engagement and group collaboration (Segalas, 2010), and (4) action-orientation and change-agent skills (Wiek, et al., 2011; Sipos et al., 2008; Rowe, 2007; de Haan 2006) (Table 2). In order to transform the way people "learn, reason, innovate, communicate, plan, predict, and organize" (Crow, 2007, p. 1), success in acquiring sustainability competencies extends beyond memorization and requires that knowledge about both behavioral change and pedagogy be incorporated into educational approaches. Hence, in the sections that follow, we first explain each competency and it's centality to sustainability, while illustrating how the four knowledge domains apply, and finally, demonstrating the most effective educational approaches to support the development of knowledge and skills for transformative action.

1. Systems Thinking and an Understanding of Interconnectedness:

A systems perspective acknowledges that the world is increasingly connected and decisions made in one area affect others in a complex array of local to global, human-environment interactions and impacts. Progressing toward sustainability entails grappling with these dynamics in the face of multiple, potentially conflicting objectives, such as improving societal welfare, providing economic opportunities and restoring or protecting life-supporting ecosystems (Sherman, 2008; Agyeman & Angus, 2003; Orr, 2002). Achieving an array of ecological, social, and economic goals can be extremely difficult and often requires choosing one benefit or cost over another (Pepper & Wildy, 2008). In the current K-12 educational model, little acknowledgement is given to these complex human-environment interactions and associated trade-offs due to the fragmentation of real systems by disciplinary subjects and the simplification of issues into multiple choice, true/false, and similar questions on standardized tests (Gruenewald, 2004). This fragmentation has led to a decoupling of nature and society in K-12 education, while the concepts and skills needed for 'systems thinking' are neglected (Nolet, 2009; Sterling, 2001). In order to bring about behavioral change among students and society, people must learn to analyze the consequences of their actions, both intended and unintended, while recognizing the tradeoffs now and into the future.

For systems learning and thinking to result in transformative change, all four knowledge domains are relevant for educational curricula. Effectiveness knowledge for systems thinking incorporates the impact of the individual into the broader picture, meaning that students need to consider the individual and collective effects of their own and others' actions over time. Since many environmental behaviors often only have a significant impact in the aggregate, cumulative action is often necessary before substantive, positive impacts occur (Stern, 2000). Although understanding the larger system is important, it may actually create a barrier to change as individuals realize that their actions alone will not lead to substantive outcomes (Agyeman & Angus, 2003). Thus, effectiveness knowledge must clearly relay that change is made through individuals acting as a part of the collective, while building the social knowledge needed to advance sustainability—that is, by establishing the ethics and expectations for individual action. By instituting social norms that promote sustainable actions, barriers to personal change (due to limited effectiveness knowledge) can be addressed. Moreover, procedural knowledge can equip students with the skills that allow them to act within the system, while declarative knowledge highlights the processes and impacts, trade-offs and complexities essential to making decisions for a sustainable future.

Using food choices as an example, an educational program embodying all forms of knowledge might convey: (1) life cycle analysis, or the human-ecosystem processes by which products are produced, consumed, and decomposed (declarative knowledge); (2) how to read labels and understand the meaning of different certifications, such as organic and fair trade (procedural knowledge); (3) the broader impacts of switching to a more sustainable diet, for instance, how fair trade affects the livelihoods of farmers or how organic farming minimizes pollution while maintaining soil fertility (effectiveness); and, (4) the social desirability of individual decisions and underlying reasons for cultural norms, such as high-meat diets in the U.S. (social knowledge). Developing educational approaches that incorporate the four knowledge domains in this manner will help build students' competence in systems thinking while fostering behavioral change pertinent for sustainability.

Through the use of real-world explorations of sustainability problems, subject matter can be conveyed in a more connected, interdisciplinary manner that acknowledges complex system interactions (Brundiers et al., 2010; Segalas, 2010; Steiner & Posch, 2006). Real-world explorations present authentic investigations of intersecting components while avoiding the over-simplifications found in hypothetical scenarios (Barab & Luehmann, 2002). On-the-ground cases should be place-based while revealing multiple and potentially conflicting goals, tradeoffs and uncertainties, and the array of related values and beliefs (Steiner & Posch, 2006; Barab & Luehmann, 2002). Place-based learning allows students to engage in their own communities while investigating real-world problems with diverse stakeholders. Problem-based learning is inherently a part of real-world explorations as students explore the problems and possible solutions to critical issues such as consumption patterns, vicious cycles of poverty, and their inter-linkages (Dale & Newman, 2005). Through such approaches, educational activities can be "enjoyable, hands-on and relevant to life outside school while addressing the problems of our world" (UNESCO, "Education for Sustainable Development," n.d.).

For instance, students could explore their local food system by tracking what they eat, where their food comes from, and how it is produced; this might require talking with cafeteria staff at their school, managers at their local grocer, and their parents, thereby also enhancing their interpersonal communications. While exploring the relationships between food miles, prices, and agricultural practices, complementary learning modules could also engage students in issues of water quality and nutrients (e.g., eutrophication), health and nutrition, labor practices, access, and equity. Throughout the exploration into their local food system, students should be reflecting upon how they can progress to more sustainable food behaviors. Rowe (2007) notes that assignments focusing on actual sustainability issues engage students and help institutions turn towards more sustainable behaviors and norms. In systems thinking approaches to institutions, it is important to note that systems are dynamic so adaptability and change is central to achieving a resilient, sustainable system. Educating for systems thinking competencies entails discovering the interconnections between people, institutions, nature and wildlife, while also generating empathy for the implications of today's decisions on future generations.

2. Long-Term, Foresighted Thinking:

The Bruntland Report defined sustainability as meeting the "needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). A commitment to future-oriented living is fundamental to sustainability (Sherman, 2008). As Wiek and colleagues (2011, p. 11) note, "the concept of sustainability calls for long-term future orientation and envisioning," including "the anticipation and prevention of harmful unintended consequences, and the imperative of intergenerational equity." Foresighted thinking involves asking questions about long-term trends and possible future scenarios, while also employing anticipatory approaches to understand, mitigate, or adaptively prepare for future changes in system dynamics (Wiek, et al., 2011; Gibson, 2006).

It also involves placing value on the future, taking responsibility and ownership of our impacts on generations to come, and promoting concepts of intergenerational equity. Gibson (2006) explains that intergenerational equity requires society to act in a way that preserves or enhances opportunities for future generations to live sustainably. As such, society should reduce over-exploitation of resources and pressures on ecological systems so that natural resources and ecosystems are available for use and enjoyment into the future.

When applying foresighted thinking to a specific content area, in this example renewable and non-renewable resources, students could learn about: (1) the earth processes involved in the creation, extraction and regeneration of resources—such as fossil fuels—over time (declarative); (2) how to make sustainable purchases based on the renewability of the products they use, for example, by choosing reusable bags made from natural cotton fibers, rather than petroleum-based, plastic bags (procedural); (3) the impacts of different types and rates of consumption on the availability of resources into the future, which could encompass concepts such as 'peak oil' and geologic time as well as activities such as graphing and calculating individual and collective rates of resource use over time (effectiveness); and, (4) patterns of resource use and availability now and into the future, with emphasis on intragenerational fairness (e.g., oil consumption patterns in developed compared to developing countries) and intergenerational equity (e.g., fossil fuel availability today versus the future) (social). These knowledge domains can be readily integrated into K-12 classrooms, for instance, by having students graph rates of consumption in math class and explore biophysical processes in earth science classes.

To incorporate foresighted thinking into the classroom, visioning exercises are a primary approach. Creating a vision for the future generally follows four basic steps of investigation: (1) where are we now (current state), (2) where are we going (based on past, present, and future trends), (3) where do we want to be (vision statement), and (4) how do we get there (action plan) (Project Learning Tree, 2006). MacKay and McKiernan (2004) emphasize that attitudes and values shape the vision individuals have of the future, creating a "foresight bias." Constructing a sound vision of the future therefore requires awareness of the causes and consequences of past events. Through visioning activities, students reflect on and discuss the social knowledge—including values and norms—surrounding their vision statements and action plans while also discussing their individual role in achieving that future. Visioning exercises exist in many forms—visual (photography, art, media), verbal (narratives, presentations, word associations), and written (statements, reports, poems) (Wiek & Selin, 2010), thereby allowing flexibility to incorporate relevant activities into a range of classes from writing and art to social studies and earth sciences.

Backcasting and forecasting are additional techniques for creating a future vision (Segalas, et al. 2010; MacKay & McKiernan, 2004). Forecasting is the most common technique used to model and depict various scenarios of the future (MacKay & McKiernan, 2004). Forecasting is simply the application of past data points projected into the future under certain conditions. Backcasting, on the other hand, involves working backward from future goals to the present after evaluating how the future could be managed and constructed to achieve possible scenarios for attaining the desired goals (Segalas, et al., 2010). Used in conjunction with visioning exercises, backcasting can inform the plans for action to get from the current state to the envisioned state. Collaborating with others during these visioning exercises is useful for promoting respect for multiple perspectives as well as for overcoming 'foresight bias' by building several scenarios of the future (MacKay & McKiernan, 2004). Each of these visioning techniques stresses the importance of individual and collective change through stories and plans for how the future should or could evolve for sustainability.

3. Stakeholder Engagement and Group Collaboration:

Overcoming barriers to sustainability requires collaboration across many scientific fields while also considering and diverse values and normative perspectives about how things ought to be (de Haan, 2006). Because sustainability problems are complex, there is no single 'right' solution. Fostering collaboration not only has the potential to mitigate or solve 'wicked' problems; it is also a matter of equitably incorporating multiple views on how to address those problems (Steiner & Posch, 2006). The interdisciplinary nature of the field of sustainability reiterates the need for inclusiveness of multiple scientific perspectives (Wiek, et al., 2011; Segalas, et al., 2010; Sipos et al., 2008; Steiner & Posch, 2006), yet science alone is not enough. The perspectives and experiences of varying stakeholders are also critical for providing local knowledge and information about the values and concerns that inform societal actions. Ultimately, stakeholder engagement and participatory decision making better fulfill public interests compared to the decisions based on the lobbying of select, powerful interests (Agyeman & Angus, 2003). Equipping students with the skills and resources to engage in collaborative decision making is essential for realizing democratic processes that reflect diverse stakeholder interests.

The four knowledge domains can be utilized to address the importance of collaboration, for example, by teaching students about: (1) multidisciplinary information and perspectives on a particular issue, such as engineering, ethical, and policy issues in nano-technology (declarative) (Barben, et al., 2008), (2) how to effectively communicate, negotiate, and resolve conflicts in support of collaborating and participating in group activities (procedural), (3) illustrating how and why sustainability projects have succeeded due to active and engaged citizen involvement, as with the Dudley Street Neighborhood Initiative in which resident-driven plans to revitalize their Boston community were developed and implemented through collaboration with local businesses and organizations (effectiveness) (Agyeman & Angus, 2003), and (4) fostering respect and tolerance of multiple ways of knowing through joint problem solving and mutual learning (social) (Steiner & Posch, 2006). In order to move away from the individualistic, competitive atmosphere, group projects can help build effective communication, team-building, and conflict-resolution skills, along with techniques for managing collaborative projects (Steiner & Posch, 2006).

Segalas et al. (2010) argue that collaboration will result in better products and processes for student learning. In a study done to compare different pedagogical approaches, they found that more community-focused, group-oriented activities resulted in higher cognitive learning and more dynamic interactions than individual approaches. Although classrooms are typically set up for individual work and most assessments are exclusively individualistic, well-established techniques exist for promoting group collaboration and stakeholder engagement. Group collaboration can involve classroom activities, such as group projects, presentations, and role-playing activities, as well as out-of-classroom techniques such as community-service learning. Role-playing—which combines real-world situations and group work—enables students to go beyond just listening to others' perspectives and into the realm of lobbying for others' interests, especially as they take on stakeholder roles and promote the perspectives of particular individuals or interest groups (Segalas, et al., 2010). A "citizen's jury" is one form of role playing in which students compile research, question "experts," and make informed recommendations based on discussion and deliberation (Agyeman & Angus, 2003, p. 353-354) Community-service learning is also an excellent way to promote group collaboration because it requires students, teachers, community members, and organizations to work together towards a common goal that is mutually beneficial.

Overall, community-oriented approaches enhance learning and facilitate understanding of multiple perspectives (Segalas, et al., 2010), while also offering a potent way to empower students to

take action locally (Sterling, 2001). Not only do students learn how to participate in civic activities and group decision-making processes—making it more likely that they will engage again—but they also develop a stronger sense of responsibility within their community (Agyeman & Angus, 2003). In linking group activities to multiple disciplines and systems thinking, students can more effectively engage in problem-solving and decision-making processes that incorporate social, economic, and environmental sciences and a range of other perspectives on complex problems.

4. Action-Orientation and Change-Agent Skills:

At its core, sustainability is a call for a change from our current trajectory, or in other words, a call to action (Barr, 2003). Sustainability cannot be achieved by simply relying on state intervention, legislation, or new technologies; it requires that people actively participate in decision making, problem solving, and sustainable change. Engaging students in active, applied learning will not only increase their understanding of the content but will also instill in them the importance of action and engagement throughout their lives. Sipos et al. (2008) explain that action learning is a form of experiential learning in which students are asked to question their assumptions and apply new knowledge and skills to diverse situations. Action learning, combined with systems thinking, stakeholder engagement, and foresighted thinking, can facilitate students' development as sustainability change agents. Promoting change agency isn't simply about taking action but also about understanding the implications of our actions, which requires emotional intelligence, interpersonal skills, and understanding of normative aspects of problems and potential solutions (Wiek, et al., 2011; Segalas, et al., 2010; Sipos, et al., 2008).

While fostering change-agent skills through active education in a specific content area, such as sustainable waste strategies, students could learn about: (1) cases in which change-agents have transformed waste strategies in their communities, for example, looking at Nova Scotia's CBSM campaign to promote backyard composting (declarative) (McKenzie-Mohr, 2000), (2) how to sort recycling and compostable materials (procedural), (3) the amount of waste diverted from landfills due to personal and collective actions in the classroom and local community (effectiveness), (4) overcoming the social stigma associated with sustainable waste strategies (e.g., composting is unpleasant) while also exploring the inequitable distribution of hazardous waste (e.g., e-waste) globally (social). The change-agency approach to education bridges social and ecological systems by exploring students' roles within society and the environment, thereby engaging concepts in the political, economic and civic realms as well as those pertaining to earth processes and the biophysical environment.

Numerous educational case studies illustrate that experiential activities lead to transformative learning (Sipos, et al., 2008; Barab and Luehmann, 2003). Segalas, et al. (2010) found active learning to be effective in teaching competencies such as systems thinking and collaborative communication skills, both of which are vital skills for sustainability change agents. Experiential lessons present an approach to active learning wherein students apply their ideas to new experiences. For example, students could apply learned knowledge about composting and seasonal foods to the task of creating and maintaining a garden (Tidball & Krasny, 2010). Unlike traditional methods, in which the hope is that conceptual knowledge will eventually lead to application, experiential lessons provide an opportunity for students to directly apply their knowledge. In addition to promoting active engagement, experiential activities also increase long-term retention. In fact, students retain an estimated 80% of knowledge, skills, and values from active participation, in contrast to only 10% to 20% of what they hear or read (Cortese, 2003). Behavioral scholars explain that direct experiences have a stronger influence on people's behavior than indirect experiences (Kollmuss & Agyeman, 2002). Hence, experiential learning has a stronger influence on behaviors than traditional lectures emphasizing declarative knowledge. Beyond providing

direct experiences, experiential education also builds students' confidence that their behaviors do in fact bring about change.

Project-based learning (PBL) is a commonly used experiential approach that prepares students for assessments while empowering them to be actively engaged in problem solving, hands-on inquiry, and collaborative learning. PBL typically involves three components: 1) a driving question that organizes a long-term, authentic investigation; 2) the production of tangible, meaningful products; and, 3) collaboration with peers, teachers, and/or members of society (Barab & Luehmann, 2003). Through project-based learning, students actively find, define, and solve problems via collaborative teamwork and active engagement. Another form of experiential education is community-based service learning. Community service is not only action-oriented and place-based but also interdisciplinary, for example teachers and students may work with horticulturists in gardens or contractors in Habitat for Humanity, or biologists in riparian projects. Engaging in community service allows students to observe their teachers, peers, and other community members demonstrating civic responsibility, which in turn fosters a sense of civic engagement as a societal norm. In order to further enhance sustainable actions as the norm, students can make public commitments or pledges in which they promise to change while also asking their neighbors and peers to make a commitment (McKenzie-Mohr, 2000). These commitments can incorporate public-speaking activities as well as artistic displays, or persuasive writing activities.

Place-based projects are also essential in creating an atmosphere in which students feel they have the personal capacity to take action. Projects are most successful when implemented where people feel empowered to act, starting at the local level (Wheeler, et al., 2008). Sterling notes that through local initiatives, "young people can gain confidence and a belief that they can make a difference, and their efforts can stimulate action by parents and the broader community" (2001, p. 68). According to the *Sustainable Design Project* (Wheeler, et al., 2008), effective learning most often occurs when in it is relevant to students' lives, where they live, learn, and play. Developing place-based projects in which the students get to see the impact of their actions is important in building their confidence to act and in developing the skills to engage in decisions about the future.

Table 2
Summary of Key Competencies and Approaches for Sustainability Education

Sustainability Competencies:	**Educational Pedagogy**
1. Systems thinking and an understanding of interconnectedness	*Concepts:* Interconnections among the environment, economy, and society, including impacts, trade-offs, feedbacks, and unintended consequences of individual and collective actions *Methods:* Real-world case studies with place-based lessons and activities Interdisciplinary approaches to problem-based learning *Avoid 'assembly-line' fragmentation of subjects and oversimplification of issues as simply right/wrong or true/false*
2. Long-term, foresighted thinking	*Concepts:* Future orientation in terms of achieving inter-generational equity, in minimizing the long-term impacts of human actions, realizing societal visions of the future and developing transition strategies and evaluative techniques *Methods:* Visioning exercises Forecasting & backcasting activities *Avoid 'one-size fits all' solutions in visioning activities*
3. Stakeholder engagement and group collaboration	*Concepts:* Democratic decision making, including intra-generational equity in participation and consideration of plural perspectives and transdisciplinary collaborations *Methods:* Community-based service learning Role-playing activities such as mock citizen jury or conflict resolution Group projects and collaborative activities *Avoid evaluating students solely based on individual activities and outcomes*
4. Action-orientation and change-agent skills	*Concepts:* Transformational consumer actions, along with civic and community engagement *Methods:* Experiential lessons including project-based learning, community service-learning, and place-based activities Commitment pledges *Avoid informational learning solely based on declarative knowledge*

Challenges and Opportunities in Educating for Sustainability:

Evolving into a sustainable society is a complex challenge which requires new ways of educating for behavior change. Yet, there are barriers to incorporating novel, effective approaches to sustainability education into the current K-12 school system. In particular, short class periods restrict activities (such as community service learning) to weekends or after-school programs, while lengthy lists of standards require teachers to cover traditional subject material rapidly, leaving little time for inquiry and debate (Barab & Luehmann, 2003). Although these factors present constraints to implementing some of the recommended approaches into the current educational system, they are not insurmountable. Many programs are already integrating place-based and project-based learning throughout the curriculum, while embedding interpersonal skills and systems thinking into traditional disciplines including math and science (Garrett & Roberson, 2008; Wheeler, et al., 2008). Collaborative projects and problem-based activities have actually been proven to improve test scores—an important part of the current system—while also contributing to the attainment of sustainability competencies (Garrett & Roberson, 2008; Barron, et. al, 1998). The transition to educating for sustainability may be slow and even piecemeal but it should be pursued immediately and continuously. Educators can begin imbedding sustainability competencies and associated pedagogy slowly, while progressing and adapting towards a new way of educating in light of changing situations and opportunities.

Education has for decades sought value-free knowledge, and thus, the idea of incorporating theories of values, beliefs and norms into education may seem out of place to some educators, students, and even parents (Sipos, et al., 2008). However, the traditional practice of detaching the course content from values and morals does not translate into the absence of values. Sipos and colleagues note, "all curricula are in fact value-laden" (p. 70). In looking towards a sustainable future, we must encourage the imparting of sustainability values and norms through emphasizing cooperative and collaborative efforts as well as promoting sustainable practices such as recycling and energy conservation. Values and normative aspects of sustainability are embedded within each of the key competencies—systems thinking suggests that we see ourselves as a part of the environment, rather than removed from or ruling over nature; foresighted thinking emphasizes intergenerational equity, hence placing a value on the needs future generations; stakeholder engagement and group collaboration promote respectful inclusion and representation of diverse perspectives; and, finally, action-orientation and change agency highlight the need to evaluate our assumptions, reflect upon our actions, and modify our choices in light of situational and structural circumstances.

Developing curriculum and programs in universities, where they tend to be prevalent (Wiek, et al., 2011; Segalas, et al., 2010; Rowe, 2007), is a great start to sustainability education, but focus on young adults is simply not sufficient to build habits and create change that will persist throughout an individual's lifetime (Shultz, et al., 2007). Working with K-12 schools allows us to not only work with youth but to work where youth spend the majority of their waking hours. Additionally, special attention to youth is essential because socially pervasive behaviors are highly resistant to change once they have formed and engrained in adulthood (Leisowitz, et al., 2005). Corroborating studies have found that habits developed during childhood or adolescence—ranging from dietary and health choices to substance abuse and more—are strong indicators of adult behaviors (Harris, et al., 2005; West & O'Neal, 2004). An investigation into recycling behaviors also found that young students who recycle at school are more likely to develop ecologically-minded waste strategies as adults (Monroe, 2003). By targeting youth and developing pro-environmental behaviors at a young age, such behaviors will become habits and the established norms of a more sustainable society (Shultz, et al., 2007; Werder, 2006; Monroe, 2003; Stern, 2000).

Conclusion

"Achieving sustainability will depend ultimately on changes in behavior and lifestyles, changes which will need to be motivated by a shift in values and rooted in the cultural and moral precepts upon which behavior is predicated" (UNESCO, 1997, p. 34). Changing individual behaviors and motivating collective action is essential to achieving a sustainable future and is therefore a central motivation of sustainability education. Professor William Scott (2002, p. 11) argues that in this way sustainability and education "are necessary bedfellows." We argue that bedding sustainability and education, while a start, may not be sufficient if the current focus on ecological, or declarative, knowledge continues. In order to truly achieve the transformative change that sustainability calls for, behavioral change motivators and constraints must not just guide the educational approaches; they must be deeply incorporated into school programs and curriculum. Schools and teachers *are* impacting the way in which students interact with society and the environment now and into the future, and this is an opportunity that must be seized and utilized in order to effectively promote sustainable behavior change.

In targeting behavior change through the knowledge domains, we go beyond information retention as a goal of educating for sustainability (see Fig. 2). Declarative knowledge can be used to create an understanding of socio-ecological interactions and interconnectedness while also reducing misconceptions and misinformation. Procedural knowledge can explain how to undertake particular actions (e.g., sorting recyclables) while also focusing on local action strategies, such as how to use local public transportation systems. Effectiveness knowledge can illustrate to students the link between their personal decisions and the consequences (both positive and negative) of their actions. Social knowledge can address barriers to change due to social stigmas or cultural norms and through propositioning sustainability actions as positive and desirable. As a whole, a robust approach incorporating diverse knowledge domains as well as other factors is essential to educating for sustainable behavior change.

We acknowledge that many other factors, beyond knowledge, influence behaviors and habits, such as structural and situational constraints. Educating for sustainability is one intervention point for promoting behavioral change but when it comes to overcoming many of these structural constraints, incentives and regulations will also be necessary. Working with schools and promoting sustainability through education is pivotal in creating change but it is not the only arena in which transformation needs to occur. We hope our conceptual approach (Fig. 2) and recommendations will help this process, but these alone are not enough. Continual application, evaluation, and adaptation are essential to assuring the long-term vision of a sustainable society is achieved.

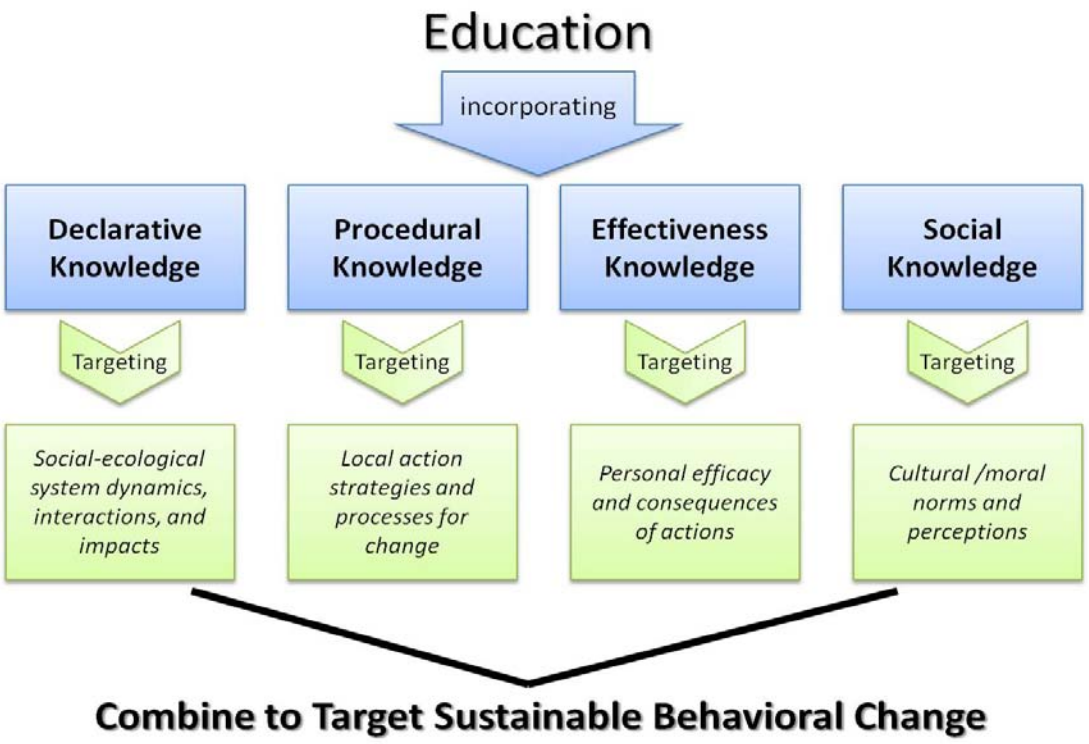

Figure 2. Targeting behavioral change through knowledge domains

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