Sustainability and STEM in a 21st century education

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The Challenge Ahead

As we enter the 21st century and watch our familiar institutions and relationships change under the strain of a globally integrated world order, we have begun to see that our traditional ways of doing things will not suffice for a new age. In particular, our traditional science, technology, engineering, and mathematics (STEM) education processes will not suffice for the people and the challenges of his new age. The Chairman and CEO of IBM Corporation, Samuel Palmisano, spoke recently to the Council of Foreign Relations[1]. His theme was "The Current Economic Environment in the United States." He made several points that set the stage for thinking about the essential elements of a contemporary liberal education. He argued that (a) We are learning more and more about how the world works as sensors embedded across entire ecosystems, supply chains, healthcare networks, and communities send back information across vastly expanding networks of communication; (b) Our world is becoming increasingly interconnected so that ideas, images, data can spread quickly from one place to another without the help or management of "experts;" and (c) Even everyday objects are becoming intelligent and can generate enormous volumes of information. Tom Friedman has used the powerful image of a "flat" world to describe this new context.

What we have not figured out yet is how to make the best use of this new continuous stream of information that our new communication systems make possible. We know a lot more but are we actually any smarter? Are our educational institutions motivating and preparing students to deal with the complex global challenges, such as climate change, public health, and adequacy of water resources, that threaten the planet and its citizens? Palmisano makes the case that the advantage will now go to places and organizations that are smarter than their competitors. Countries, regions and communities that have a smart infrastructure will do well---smart transportation systems, modern airports, secure trade lanes, reliable energy grids, trusted financial markets and an enhanced quality of life. Underlying all of these conditions is the concept of sustainability. In sum, "the enterprises, countries and communities that provide the smartest, most connected and most open environments for [the] coming generations to grow and innovate will be the ones that win."[2] This emphasis on coming generations is at the heart of sustainability, one definition of which is this:

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[1] Speech presented on November 6, 2008. Retrieved on 2/19/2009 from www.cfr.org/publications/17705

[2] IBM Corporation 2007-2008 Corporate Responsibility Report. Letter from Samuel J. Palmisano.

> Sustainability is related to the quality of life in a community – whether the economic, social and environmental systems that make up the community are providing a healthy, productive, meaningful life for all community residents, present and future.[3]

Palmisano predicts, as do many other futurists, that "businesses, societies and communities will soon begin to transform their systems, operations, enterprises and personal lives to take advantage of"[4] the interconnected world that is opening up in front of us. The same is true of education, in particular, of STEM education.

What does it mean to be educated?

In the 107th Yearbook of the National Society for the Study of Education,[5] David Coulter and John Wiens summarized an extraordinarily rich and insightful series of essays and conversations about education. They pointed out that across the different ages and stages of life, the vision of an educated person is the same: Educated people "attempt to make a difference in the lives of others; they use their knowledge and understanding in their engagements with other citizens, listen respectfully and thoughtfully, and act with honesty and diplomacy. In other words, they exhibit certain traits of character" (footnote 4, p. 10).

Tracking all the way back to the classical philosophers, Coulter and Wiens ground these qualities in the two principles of wisdom---*sophia* (the pursuit of deep understanding) and *phronesis* (practical wisdom, the ability to know the right thing to do in a particular situation and the porpensity to act accordingly) (footnote 4, p. 13.) The most fully developed and contemporary perspective on the elements that should make up a practical liberal education that combines *sophia* and *phronesis* can be found in Greater Expectations[6] and its successor, Liberal Education and America's Promise (LEAP)[7].

The LEAP Essential Learning Outcomes are designed to prepare students at all levels of education. As a student progresses to successively higher levels, both the intellectual complexity and the significance and importance of problems will continue to expand and performance expectations will continue to rise. Together, the complexity and importance of the questions and the realities of active involvement in the design of workable solutions will prepare students for the experiences and challenges that await them upon graduation. The

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[3] Retrieved from http://www.sustainablemeasures.com/Sustainability/index.html on February 27, 2009.
[4] IBM Corporation 2007-2008 Corporate Responsibility Report. Letter from Samuel J. Palmisano.
[5] Coulter, David L, and John R. Wiens (Editors) and Gary D. Fenstermacher (Series Editor). (2008) Why do we educate? Renewing conversations. Volume One. Prologue: Renewing the Conversation.pp. 6-20.
[6] Greater Expectations: A New Vision for Learning as a Nation Goes to College. (2002). Washington DC: Association of American Colleges and Universities. 60 pages.
[7] College Learning for the New Global Century (2008). Retrieved from http://www.aacu.org/leap/documents/GlobalCentury_ExecSum_3.pdf on February 27, 2009.

basic premise behind the model is actually captured nicely in a very different document, the Brown University Task Force on Undergraduate Education Report, September 2008. This document states:

- A curriculum should be more about context than content and more about the basic conditions that foster learning rather than the subjects learned.
- The most important social, political, scientific and moral challenges of any era have always demanded the ability to navigate multiple points of view and the application of the tools of many disciplines.
- The curriculum has always reflected the changing landscape of American culture and the challenges of nation-building.

The components of a 21st century education as articulated by LEAP offer a powerful set of expectations for what a contemporary education should entail.

- ✓ Knowledge of human cultures and the physical and natural world.
  Focused by engagement with big questions, both contemporary and enduring
- ✓ Intellectual and practical skills
  Practiced extensively across the curriculum, in the context of progressively more challenging problems, projects, and standards for performance
- ✓ Personal and social responsibility
  Anchored through active involvement with diverse communities and real-world challenges
- ✓ Integrative learning
  Demonstrated through the application of knowledge, skills and responsibilities in new settings and complex problems.

It should be evident that this formulation of a well-balanced and purposeful education requires an especially complex set of Big Questions that provide the resources, the challenges, and the opportunities for application that can undergird a meaningful education. The sustainability agenda offers an especially important and challenging set of Big Questions. Students care about these questions. They want to become active contributors to solving environmental problems. They want to study in places that share their concern and take sustainability seriously. They themselves want to be taken seriously as well. They are embracing sustainability.

The STEM disciplines are an integral part of such a comprehensive 21st century education. Indeed, I believe - and research indicates - that such a global context for STEM education will improve learning for all students. That is, a framework of sustainability for the STEM disciplines can easily incorporate all of the components of a powerful education noted above. It can provide both an effective vehicle for learning the 21st century STEM disciplines generally and the basic tools by which we can address our global challenges.

Sustainability as a Context for a 21st Century Education. In a prospectus entitled "A Call for Climate Leadership,"[8] the American College and Universities Presidents Climate Commitment (ACUPCC) set out an agenda for the future that would embrace a concern for the environment and for sustainability as an institution-shaping goal of the nations' colleges and universities. As ACUPCC explains it, "Colleges and universities are ideal settings to develop workable new strategies, systems, behaviors and technologies that can be scaled up to the community and state levels. By involving students, faculty and staff, these institutions can become effective models for achieving climate neutrality and sustainability." This institutional commitment can also strengthen an institution's liberal education program, which must include the STEM disciplines.

The definition proposed by Sustainability Measures (footnote 3) quoted earlier emphasizes the interconnections among the economy, society and the environment. The comprehensive approach required to support a community-wide approach to sustainability represents a grand integration, the kind that addresses the most sophisticated of the LEAP Essential Learning Outcomes. By their very nature, the STEM disciplines offer an especially compelling pathway to meaningful integration across fields. Our students must learn that most BIG questions cannot be explored through the lens of a single discipline or even through a lens that encompasses only STEM disciplines; the global challenges that face us involve other frames of reference as well, such as economics, ethics, and political science. The full realization of a sustainability theme as an institution-shaping strategy not only can provide an effective vehicle for the learning of STEM at a higher level for more students, but also can address every aspect of the LEAP Essential Learning Outcomes.

Summary

This reflective essay attempts to make the case that sustainability offers an especially powerful context in which to promote the kind of learning that will prepare students for life and work in the 21st century. My basic argument is the following:

- A 21st century education must address Big Questions in a meaningful and engaging way, and learning must have consequences in real-world contexts.
- Our students must learn to distinguish a question that can be adequately explored only through a STEM lens from one that requires integration of STEM with other disciplinary and experiential frames of reference.
- Sustainability is an especially effective Big Question to engage students and to achieve the improvement in STEM education and the instantiation of the essential learning outcomes in this nation's undergraduate education.

There is a close alignment between the way that the world is changing and our growing expectations of what can be accomplished during an undergraduate experience. Liberal

[8] A Call for Climate Leadership. Retrieved Feb. 27, 2009 from http://www.presidentsclimatecommitment.org/pdf/climate_leadership.pdf

Education and America's Promise offers a portrait of the core components of a 21st century education that aligns closely with the realities of a globally integrated world. The exploration of environmental and sustainability questions can offer an especially powerful way to learn, including how to apply knowledge, insights and values from different disciplines and different frames of reference to the kinds of problems that now confront us all in an interconnected world where each of us can have a voice and where each of us can make a difference.