Beyond Standards

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Publication of STL was a leap forward in identifying knowledge needed for life in a technological world.

- **However, hundreds of benchmarks have been written in national and state STEM frameworks, and standards have been criticized as vague, repetitive, and poorly coordinated [2].**
- **Donovan and Bransford concluded that factual knowledge must be placed in a conceptual framework to be well understood [3].**
- **To facilitate learning transfer, students should encounter the same concept in a variety of contexts ; and schemata (or knowledge structures) are needed for them to transfer learning to new situations and develop conceptual understanding [4].**

2. National Research Council. (2008). *Common Standards for K-12 Education? Considering the Evidence.* A Workshop Series. Alexandra Beatty, Rapporteur. Center for Education, Division of Behavioral and Social Science and Education. Washington, DC: National Academies Press.
3. Donovan, M. S., and Bransford, J. D. (2005). Introduction. In M. S. Donovan and J. D. Bransford (Eds.). *How students learn: History, mathematics, and science in the classroom* (pp. 1–28). Washington, DC: National Academies Press.
4. Bransford, J. D., Brown, A. L., and Cocking, R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academies Press.

Unifying Themes

- The practice of starting with unifying themes to establish curriculum frameworks is not new. Using a thematic approach has gained attention in influential publications from the NRC, AAAS, NAEP, and by a 2009 NAE K-12 ETE committee [5].
- Custer, Daugherty, and Meyer conducted a study that included a literature review and focus group meetings in 2010 to identify a conceptual base for secondary school K-12 engineering [6].
- A consensus regarding conceptual themes and social contexts that might provide a foundation for ETE curriculum was produced by a 2009 international study involving 32 ETE experts from nine countries conducted jointly by Hofstra and Delft (the Netherlands) Universities in [7].

5. Sneider, Cary, and Rosen, Linda P. *Toward a Vision for Engineering Education in Science and Mathematics Standards.* Commissioned Paper. Workshop on Standards for K-12 Engineering Education. National Academy of Engineering. June 26, 2009.
6. Custer, R., Daugherty, J., and Meyer, J. (2010). *Formulating a Concept Base for Secondary Level Engineering: A Review and Synthesis.*
7. Hacker, M., Rossouw, A., and de Vries, M. (2009). CCETE Project: Concepts and Contexts in Engineering and Technology Education. Hofstra University. Available online at www.hofstra.edu/pdf/Academics/Colleges/SOEAHS/ctl/CTL_Edu_Initiatives_CCETE_revised.pdf.

Relevant and Authentic Contexts

- In both studies, social issues emerged as important to Engineering and Technology Education.
- Shouldn't ETE consider curricular contexts that are authentic - and relate to improving quality of life.
- Many students wish to use their education to influence the future, and school-based engineering meets the needs of "millennial students who are civic-minded, team-oriented, and want to make a difference." [1]

1. Gleason, Paula. Meeting the needs of millennial students. *In Touch Newsletter*, Volume 16, Number 1. Student Services, CSULB. Winter 2008.

Conceptualizing Engineering and Technology Education for All

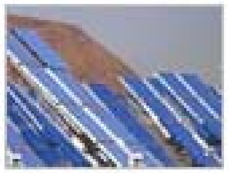
The UN *Millennium Development Goals* inspire curricula that prompt learners to seek solutions to human needs—access to potable water, sanitation and waste disposal, energy, sustainable transport, and regulated food production.

The century ahead poses challenges as formidable as any from millennia past, and in addition to the workforce and economic imperatives, ETE can and should be appreciated as a contributor to sustainable development and transformative improvement in quality of life.

Our expectation is that students will develop predispositions to forge a sustainable future, and learn that engineering and technology are routes through which they might engage in this work in their adult lives.


Advance health informatics


Restore and improve urban infrastructure


Make solar energy economical


Provide access to clean water

NEXT

Marc de Vries
CCETE International Study

Rod Custer and Jenny Daugherty
Formulating a Concept Base

David Burghardt
Curricular Next Steps

Mark Sanders
A Summary Perspective

Curriculum Design Opportunities—and Challenges

EfA points to using a societal need to drive the curriculum, the contexts and themes.

Table 2. EfA Themes and Contexts Matrix

Conceptual Themes →	Design				Modeling				Systems				Resources				Human Values			
	P-2	3-5	6-8	9-12	P-2	3-5	6-8	9-12	P-2	3-5	6-8	9-12	P-2	3-5	6-8	9-12	P-2	3-5	6-8	9-12
Contexts																				
Food																				
Energy																				
Health/Safety																				
Mobility/Transport																				
Shelter																				
Water																				

Note: Design Tasks and Differentiated Assessments Will Be Developed For Each Middle School Module.

In each cell, AAAS, NAEP, NCTM, NRC, and STL grade-level benchmarks/standards will illuminate the themes in context.

Consistent with earlier efforts in Science, Technology and Society (STS)

Build on existing standards and evolving requirements.

- Standards for Technological Literacy
- NAEP
- AAAS Benchmarks
- Common Core Science

Lessons from Interconnected STEM

Knowledge Integration—the theory of how learners connect disciplinary knowledge (Learning and Cognitive Sciences)

Interconnected Learning—the implementation level of Knowledge Integration

Starting Point for STEM Infusion: Teacher skills and knowledge

Teachers must have adequate STEM content knowledge.

Teachers must have adequate pedagogical skills to teach the STEM content.

Teachers must value infusion of STEM content and be able to support student STEM learning.

Example of Math Infusion in ETE
(part of predictive and representative modeling)

- Be meaningful and difficult for students
- Fit naturally into ETE
- Facilitate the learning of ETE
- Be introduced multiple times in different contexts to assure student learning and ability to apply
- Build in complexity

Classroom Teacher Change

- Role of professional development
- Continuing education

What does this look like? What are teacher backgrounds and requirements for providing interconnected learning?

University Faculty and Institutional Change

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