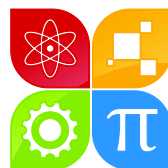
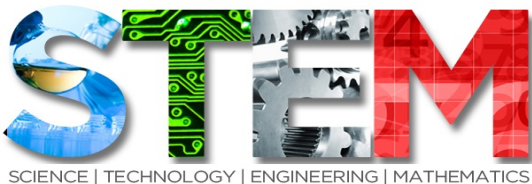


Secondary STEM

Design-Driven Problem Solving: EbD for Grades 6-12

Jennifer Buelin, Ed.D., NBCT
Director, ITEEA STEM CTL



ITEEA: Who We Are

Advancing Technological and Engineering Capabilities for ALL

Global Membership Services and International ITEEA STEM Centers

IdeaGarden

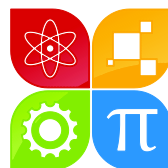
ITEEA

STEM Leadership and Growth Opportunities

Recognition & Awards

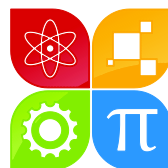
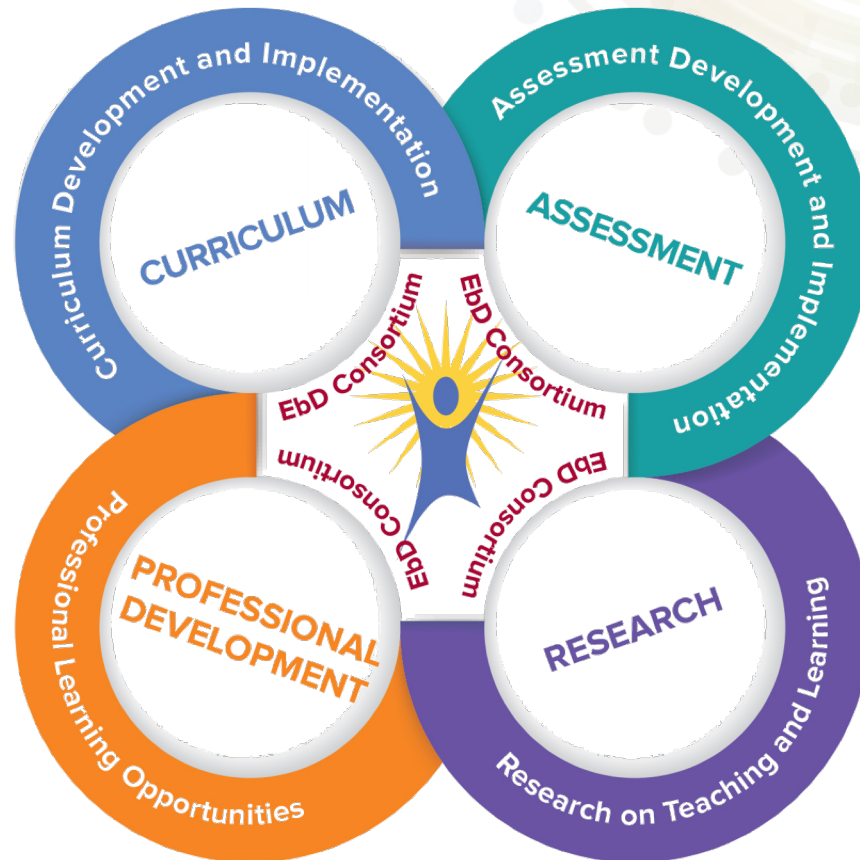
Professional Development

Building Capacity through the STEM Center for Teaching and Learning



ITEEA's STEM Center for Teaching and Learning:

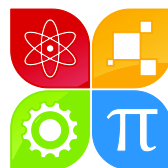
the hub for industry
standard integrative
STEM education
content
development,
research,
assessment, and
professional
development



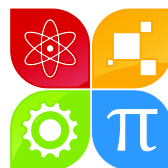
Integrative STEM Education is operationally defined as:

"the application of technological/engineering **design based** pedagogical approaches to **intentionally teach content and practices of science and mathematics education through the content and practices of technology/engineering education**. Integrative STEM Education is **equally applicable** at the natural **intersections** of learning within the continuum of **content areas, educational environments, and academic levels**" (Wells & Ernst, 2012/2015)

(as adapted from Wells/Sanders VA Tech program documents 2006-10).



- The Goal of the STEM Center for Teaching and Learning™ (STEM CTL™) is to develop the premier, nationally recognized model for Integrative STEM Education (I-STEM Education) programs.
- The Center is addressing this goal in the Engineering byDesign™ (EbD™) curriculum through the ITEEA 6E Learning byDeSIGN™ Instructional Model. This model effectively integrates STEM subjects and relevant themes, and its use of research-based constructivist learning practices empowers students as lifelong learners.



6E Learning byDesign



ENGAGE

The purpose of the ENGAGE phase is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.



EXPLORE

The purpose of the EXPLORE phase is to provide students with the opportunity to construct their own understanding of the topic.



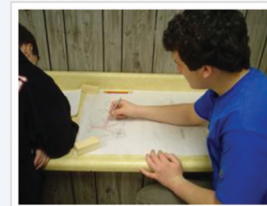
EXPLAIN

The purpose of the EXPLAIN phase is to provide students with an opportunity to explain and refine what they have learned so far and determine what it means.



eENGINEER Extend/Elaborate

The purpose of the eENGINEER phase is to provide students with an opportunity to develop greater depth of understanding about the problem topic by applying concepts, practices and attitudes.



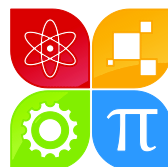
ENRICH

The purpose of the ENRICH phase is to provide students with an opportunity to explore in more depth what they have learned and to transfer concepts to more complex problems.


















EVALUATE

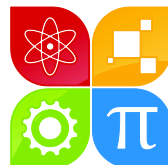
The purpose of the EVALUATION phase is for both students and teachers to determine how much learning and understanding has taken place.



K-12 Standards-Based Integrative-STEM Model

CORE PROGRAM	PreK-2		EbD-TEEMS NXTGEN™		1-6 weeks
	3-6		EbD-TEEMS NXTGEN™ (6th Grade Capstone), I ³	 	1-6 weeks
	6		Exploring Technology		18 weeks
	7		Invention and Innovation		18 weeks
	8		Technological Systems	 	18 weeks
	9		Foundations of Technology	 	36 weeks
	10-12	HS Choices	Technology and Society		36 weeks
	10-12		Technological Design		36 weeks
	11-12		Advanced Design Applications		36 weeks
	11-12		Advanced Technological Applications		36 weeks
	11-12		Engineering Design (Capstone)	 	36 weeks

Endorsed by





NATIONAL ACADEMY OF ENGINEERING

NAE GRAND CHALLENGES FOR ENGINEERING



Advance Personalized Learning



Prevent Nuclear Terror



Enhance Virtual Reality



Make Solar Energy Economical



Engineer Better Medicines



Reverse Engineer the Brain



Restore and Improve Urban
Infrastructure



Advance Health Informatics



Provide Access to Clean Water



Secure Cyberspace



Manage the Nitrogen Cycle



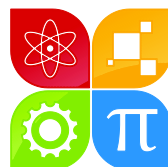
Provide Energy from Fusion



Develop Carbon
Sequestration Methods

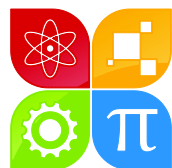


Engineer the Tools of Scientific
Discovery



Engineering for All – **Food: Vertical Farming** Engineering for All – **Water: The World in Crisis**

- Each 6 week unit is based on STL, NGSS, and NAE Grand Challenges
- Project Drivers:
 - Promoting the potential of engineering as a social good.
 - Revisiting overarching themes (design, modeling, systems, resources, and human values).
 - Using authentic social contexts for teaching and learning STEM ideas and practices.
 - Using *Informed Design* as the core pedagogical methodology.



Informed Design

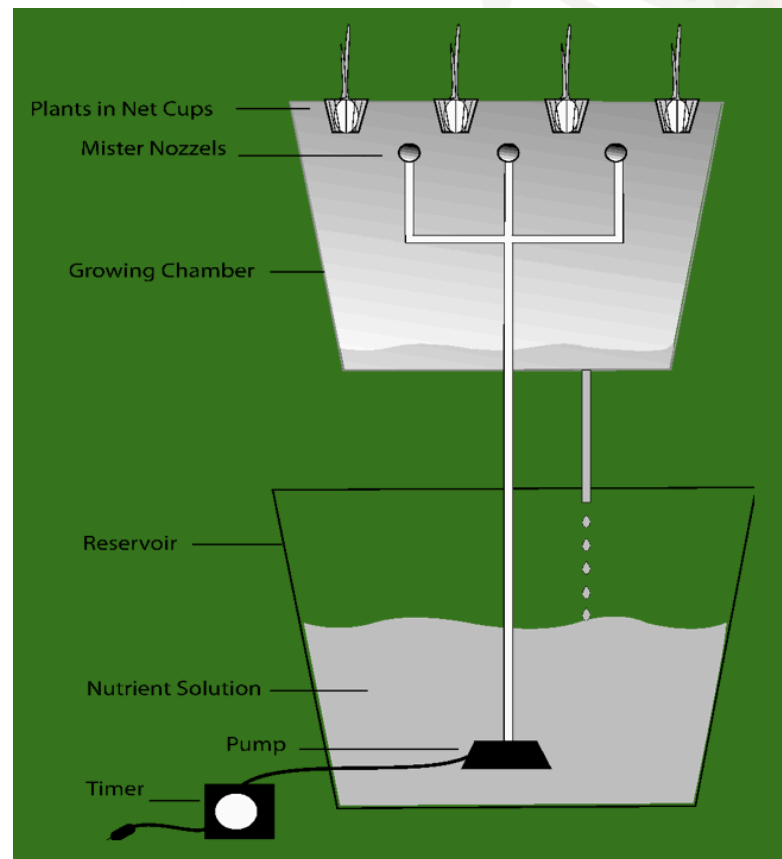
-enables students to enhance their own related knowledge and skill base before attempting to suggest design solutions. In this way, students reach design solutions informed by prior knowledge and research, as opposed to trial-and-error problem solving where conceptual closure is often not attained.

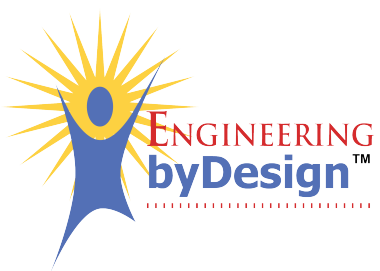


EbD/TI Course Integration: *Engineering for All* (Grade 8)

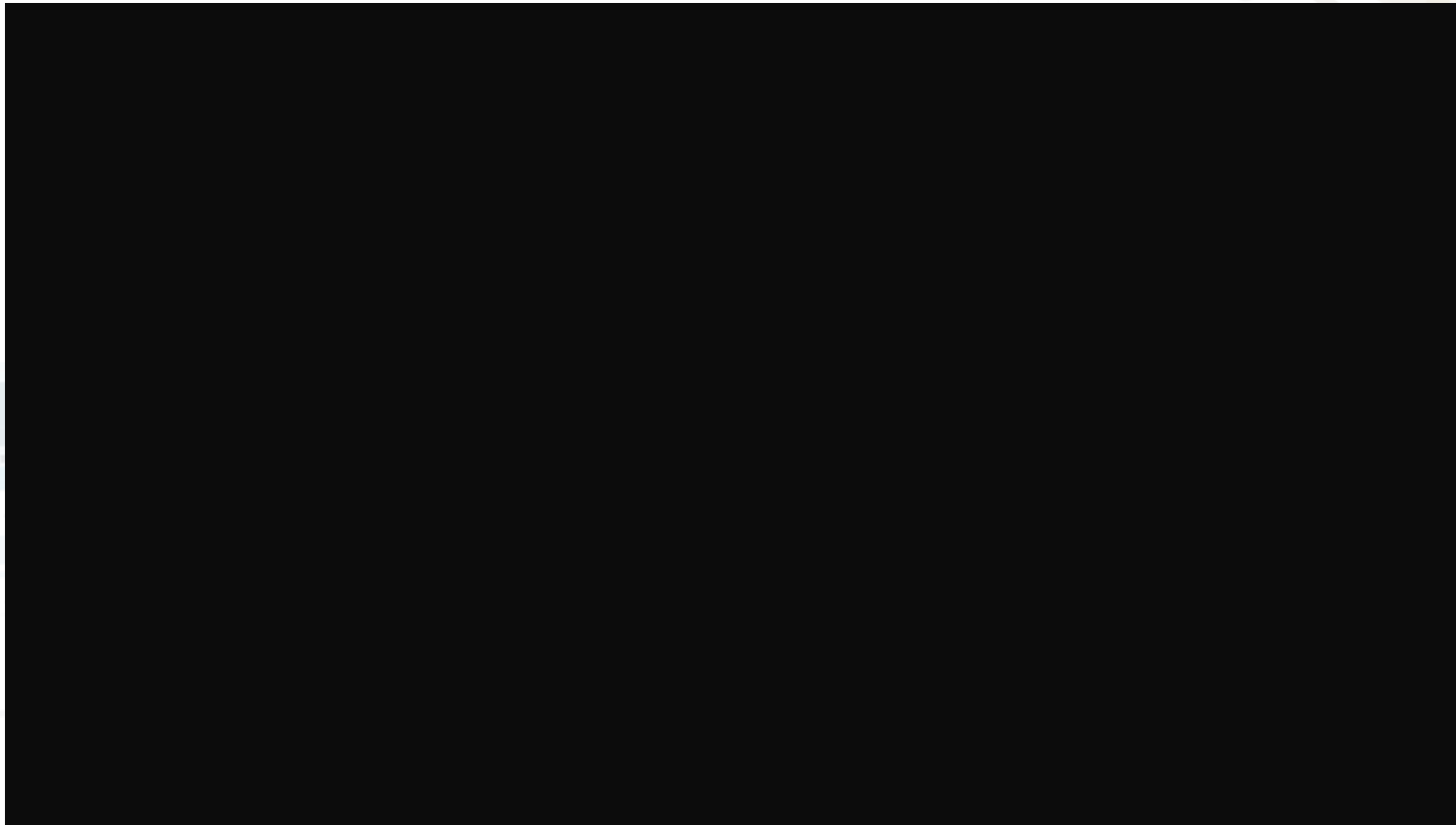
Beyond the initial hydroponics design challenge:

- Sensors (humidity, temperature, etc.)
- Controls (mistors, pumps, etc.)





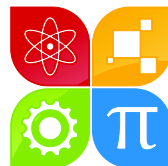
EbD™ Engineering for All



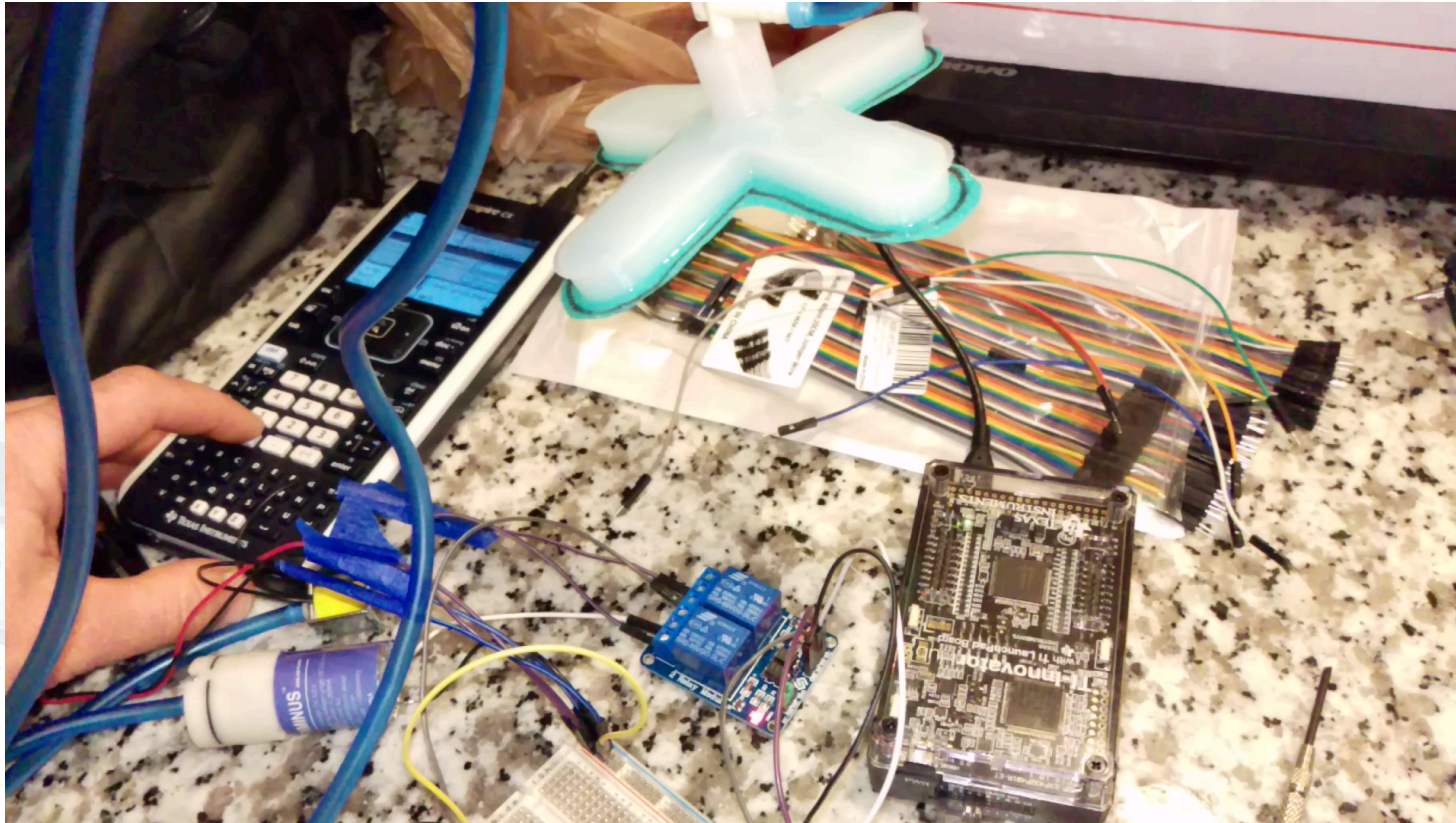
Soft Robotics for EbD™

Robotics and automation technologies have a significant impact on our daily lives

Soft Robots are an emerging field of robotics in which materials are soft and pliable

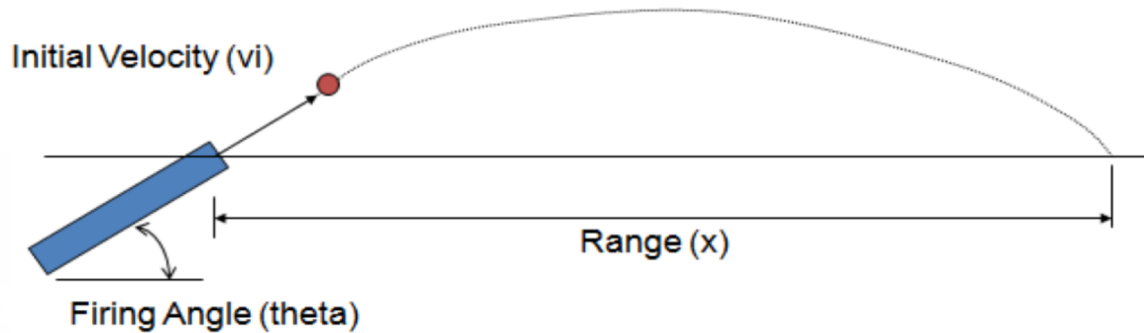


EbD/TI Course Integration: Robotics



EbD/TI Course Integration: Foundations of Technology (Grade 9)

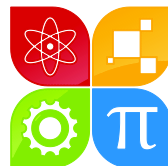
Directions: Use the picture below to determine the firing angle of your device. When complete, test the device and record the results from testing below. Document how the device was redesigned to increase efficiency.



Beyond initial analysis:

Mathematical description of marshmallow's flight;
Predictions;
Calculate max height knowing flight time, etc.

Trial (30 second interval for each point range)	1 Point		2 Point		3 Point	
	# of Shots	# of Baskets	# of Shots	# of Baskets	# of Shots	# of Baskets
Trial 1						
Percentage of Success						
Trial 2						



Exploring and Colonizing Mars

The 6E Learning Cycle in Practice



Humans have always had an innate desire to explore past the boundaries of earth to the moon and beyond. What do humans need to know and be able to do in order to colonize Mars and live there for an extended period of time?



How to design a rover/robot to navigate and traverse the Mars surface to assist astronauts in the exploration and colonization of Mars?



Before we can solve a problem, we must understand it as thoroughly as possible. What exactly are we being asked to do? What resources are available? What are the specifications and constraints for solving the problem? How will we know if we have succeeded?



Apply Engineering Design Process:

- Problem identification
- brainstorming
- specifications and constraints
- multiple iterations
- predictive analysis
- modeling
- testing and evaluation
- product refinement



How can the lessons we're learning here apply to other kinds of problems we might encounter in colonizing Mars? How else might the Mars Coleman assist with other problem scenarios? What about other environments, like deep sea research?



Self evaluation
Peer evaluation
Teacher evaluation

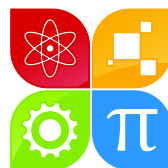
Identify STEM practices needed to solve this problem
What about other workforce knowledge and skills?



Request Preview Access to EbD courses



Or Google “EbD BUZZ Resources” and scroll down to [Request for EbD™ Course Review Access](#)



- STEM⁴ : The Power of Collaboration for Change:

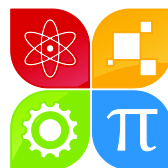
<https://tinyurl.com/STEMpolicypaper>

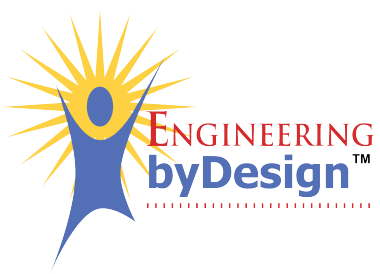
- ITEEA Reach Challenge

<https://tinyurl.com/ITEEAreachchallenge>

- ITEEA STEM School of Excellence Award

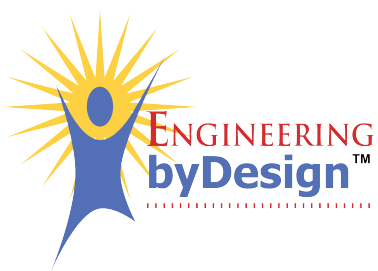
<https://tinyurl.com/STEMschoolITEEA>





Questions and Next Steps?





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Director, ITEEA/STEM Center for Teaching and Learning
jkbuelin@iteea.org

