Realities and Starting Points for Professional Development

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STEM Education

- **“STEM” is replacing “MST” Nationally**
- **Links four educational communities:**
- **Science**
- **Technology**
- **Engineering**
- **Mathematics**

You are known by the company you keep. We are in good company.

STEM Education includes T&E

- **Remember that STEM includes *T* and *E***

Tech**E**d has a central role to play

in s**TE**m

by providing context

- **And…….without context**

STEM is just …..*S & M*

Is TechEd Up To the Challenge?

- **We talk about being part of a contemporary STEM education model**
- **Will our present teachers be able to rise to the challenge?**
- **Will new teachers be adequately prepared?**

Addressing STEM Goals

- **A prime goal for K-12 STEM Education is to further the intellectual capability of all students ….**

  …...to understand the technologically complex world we live in through a system (engineering and technology) that meaningfully connects mathematics, science and social sciences and humanities.

- **Are our teachers up to this challenge? Professional development must address the need.**

Can the present TechEd Teachers address Core Engineering Ideas?

A Professional Development Challenge

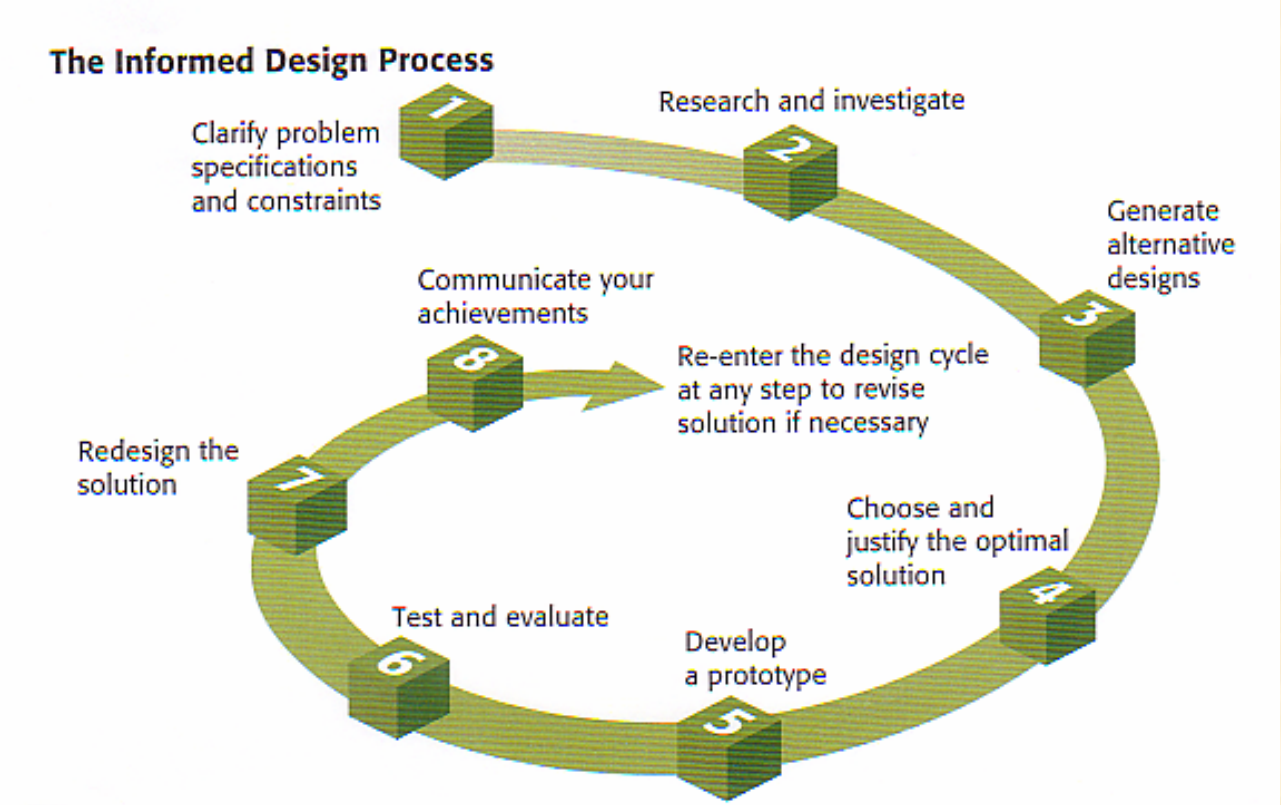
Habits of Mind	"Informed" Engineering Design
●Visualization ●Optimism ●Creativity ●S,M,SS Connections ●How Things Work ●Systems Thinking	●Informed by knowledge and skill ●Optimization/Tradeoffs ●Ethics, and Societal Impacts ●Modeling, Analysis, and Scientific Inquiry

Lessons Learned From NSF Projects

- **Seven NSF Projects run since 1992**
- **Next several slides relate to ideas that evolved during the conduct of a five-year MSP (2003-2008)**

Mathematics, Science, Technology Partnership

Informed Design



Math Infusion – Knowledge and Skill Builders

KNOWLEDGE AND SKILL BUILDERS

A key idea in the informed design process is to have scaffolding math, science and technology activities that "inform" student knowledge before the design is attempted.

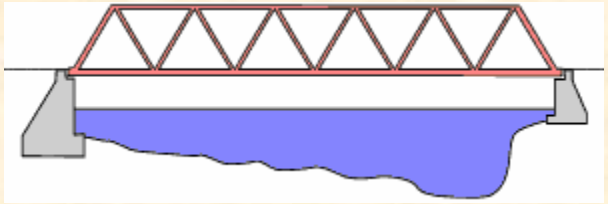
These activities are called Knowledge and Skill Builders (KSBs).

The process is very consistent with the "backwards design" process advocated by Wiggins and McTighe.

Examples of Middle School Math KSBs

- ***TRUSS BRIDGE DESIGN***

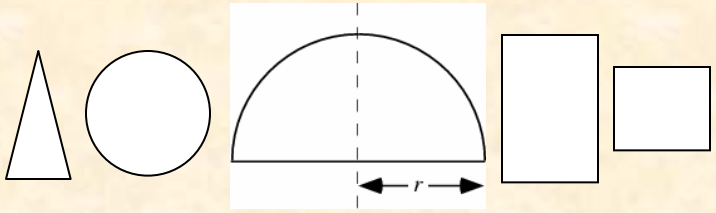
  Write a formula that will tell us the number of members for a truss with a particular number of triangles



- ***BEDROOM DESIGN***

  Scale. Scale models help in visualizing what a finished room will look like. Make three scale drawings of a room that measures 12 feet by 15 feet. Make one drawing for each ratio: ½ inch = 1 foot, 1 inch = 1 foot, and 2 inches = 1 foot

  Ratio and proportion. Window Area must be 20% of the floor area. Design a window using a geometric shape of your choice.



High School Math KSBs

- ***Drying by Design***

  This data resulted from students dehydrating fruit slices of varying thicknesses. Plot the data for each thickness on the same graph paper or spreadsheet. Compare the resulting curves.

1/8" Thick	
time (hr)	weight (g)
0	36.9
0.5	28.3
1	22.1
1.5	18.5
2	14.7
2.5	12.3
3	11
3.5	9
4	8
4.5	8.6
5	7.4
5.5	7.4

1/4" Thick	
time (hr)	weight (g)
0	30
0.5	26
1	22
1.5	19
2	16
2.5	14
3	12
3.5	11
4	10
4.5	8
5	7
5.5	6
6	6

3/8" Thick	
time (hr)	weight (g)
0	30
0.5	28
1	27
1.5	26
2	25
2.5	24
3	23
3.5	21
4	20
4.5	18
5	17
5.5	16
6	15
6.5	13
7	12
7.5	11
8	10
8.5	9
9	8
9.5	8
10	8

What about the M in STEM??

- What mathematics do students require?
- Of the standards-based mathematics, what mathematics can be contextualized?
- What about our teachers' mathematics preparation?

Getting to Know the Math

- **Some mathematics can be embedded into TechEd. Some 8th grade examples are:**
  - **Calculate distance using a map scale**
  - **Understand that numerical information can be represented in multiple ways**
  - **Create a graph given a description or an expression for a situation involving a linear relationship**
  - **Use the Pythagorean Theorem to determine the unknown length of a side of a right triangle**

Source: NYSED Core Mathematics Curriculum

A Case Study – 8th Grade Math

- **Some of the required mathematics cannot easily be conxtualized within grade-related TechEd. Some 8th grade examples are:**
  - **Divide a polynomial by a monomial**
  - **Factor a trinomial in the form $ax^2 + bx + c$**
  - **Calculate missing angle measurements when given two parallel lines cut by a transversal**
  - **Determine the prime factorization of a given number and write in exponential form**

Source: NYSED Core Mathematics Curriculum

Knowing the math means…

- Knowing math content
- Knowing math pedagogy
- Knowing what math is in the standards
- REALLY knowing the math also means knowing how to teach it.

Technology Teacher Education

Name of University	Math Requirement
Ball State	One Course
Bowling Green	None
Buffalo State College	Two Courses
Brigham Young	One Course
California University of Pennsylvania	Two Courses
College of New Jersey	One Course
Illinois State	One Course
Millersville	One Course
Montana State	One Course
North Carolina State	One Course
Ohio State	4-5 Credits
Old Dominion	One Course
Oswego	One Course
Southwestern Oklahoma State	One Course
Stout State	One Course
University of Southern Maine	One Course
Virginia State	One Course

MSTP Professional Development Model

These essential elements have been identified by MSTP for professional development:

1) Guided collaborative lesson plan design, implementation, feedback and revision

2) Supported academic year implementation

3) Peer review and learning communities.

Exemplary Lesson Planning

Model Lesson Plan Elements

- **Lesson Objectives**
- **Background Knowledge Required**
- **Preconceptions/Misconceptions that might Impede Understanding**
- **Math and Science Performance and Process Standards to be Addressed**
- **Math that Informs Science/Technology**

Exemplary Lesson Planning

Model Lesson Plan Elements, Continued

- **Assessment Strategies that will be Used**
- **Pedagogical Practices to be Employed**
- **Detailed Instructional Planning**
- **Reflection re: the Day's Lesson**
- **Pre/post Assessment**

Lesson Implementation and Fine Tuning

Lesson Plan Implementation

- **On the first day, teachers come with the beginnings of their lesson plan template filled out.**
  - During after-school meeting, teachers work in grade- and discipline-level teams to refine their plans.
- **Teachers Implement the lesson with their classes.**
  - During implementation, teacher collect high, medium, and low student work examples
- **The teachers return with their lesson plans, student work, assessments of student learning, and their own reflections**.
  - A critique of student work will occur within a peer review format. This is a learning community where teachers critically examine the quality of the work. The lesson plan is revised based on student attainment of instructional goals.

Teacher Reaction to A/B Workshops

STEM Teacher Responses

- 98.2% of all teachers found the A/B workshops to be very useful or useful (n=180)
- 90% teachers from participating schools stated they were able to use the MSTP lesson template to create a successful lesson that included enhanced math and/or that infused math into science/technology
- Over 90% of the teachers stated they would use the MSTP lesson they created in their classrooms again.
- 90% of teachers believed they spent enough time working with teachers from their own discipline
- Only 60% of teachers believed they spent enough time working with teachers from other disciplines.

MSTP Results after Five Years

- **MSTP external evaluators report that of the original eight schools on the No Child Left Behind (NCLB) Schools in Need of Improvement (SINI) list, seven are now "In Good Standing"**
- **The percentage of students passing the NY state eighth grade mathematics assessment increased in eight of the targeted 10 districts.**
- **Participating higher education faculty increased their knowledge about and involvement in middle schools, changed their teaching pedagogy to include more inquiry based methods.**

Some Research Findings

Infusing Math into Bedroom Design

- **n = 128 students**
- **A paired t-test indicated the difference was statistically significant, providing evidence that students were showing gains on their math content knowledge. $t(128) = 2.828$, $p<.005$**

Math Infusion - Challenges

SOME MAJOR CHALLENGES

- **Restructuring undergraduate Technology Education**
- **Professional development for present teachers**
- **Examples and materials for infusion of mathematics into Science, TechEd, and other subjects**
- **Research that supports value of Engineering and Technology Education in improving core knowledge areas.**
- **Changing education/certification requirements so engineers can more readily enter middle/high school teaching.**

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