Systems and Global Engineering: A Pilot Study for High School Students and Teachers

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Why Systems Engineering?

Why Global Engineering?
Today's students will work in a globalized and interconnected world

Technological literacy skills are vital for tomorrow’s workforce

The science & engineering job market in the U.S. grew by 4.2% over the last 20 years, but degrees awarded in these fields grew by only 1.5%.

Employers expect those they hire to apply knowledge in new and unusual contexts, work collaboratively and communicate effectively.

Need for high quality K-12 STEM curricula, especially in engineering and technology

Innovation and creativity essential to a holistic engineering design approach

Priority #1: Increase America’s talent pool by vastly improving K-12 science and mathematics education

Need to connect required science and math content to relevant, real-world problems found in engineering in a creative, multidisciplinary, hands-on context.

An 11% increase in the U.S. engineering workforce—or 160,000 new engineering jobs will be created by 2016.

The number of students earning bachelor’s degrees in engineering dropped by 30% between 1985-2000.

Need to interest more underrepresented students in engineering, particularly girls and minority students.

Critical: A new workforce of problem-solvers, innovators, and inventors who are self-reliant and able to think logically

National Governor’s Association (2007). Innovation America: Building a Science, Technology, Engineering and Math Agenda
Ground-breaking, 21st Century collaboration opportunity!

Opportunity to design a solution to a complex problem!
Year One Efforts

- Develop 4 HS level modules
- Provide PD to 20 pilot teachers
- Begin to pilot materials
Curriculum Modules
Focus → Global Sustainability

1. Core Concepts of Systems Engineering
   - Students will reverse-engineer a common device that contains both electrical & mechanical components and create a systems diagram for the deconstructed device. Schools will swap reassembly instructions and diagrams and attempt to reconstruct the device.

2. Water Purification
   - Classes around the world will be paired together to design and produce a water purification system to be used in a developing country.
Curriculum Modules
Focus → Global Sustainability

3. Home Lighting in Developing Countries
   – Students will design and develop a prototype solar lighting device that is able to harness the sun's power during the day and can meet general lighting needs. Students will work on design, prototyping, manufacturing and marketing teams.

4. Biodynamic Farming
   – Students will research biodynamic farming systems, conduct investigations, and collaborate to design an aquaponics system that sustains plant and animal life. Classes will contribute to specific subsystems designs.
## Paradigms for Student Collaboration

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>Type of Interaction / Benefit</th>
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<tr>
<td>Sharing</td>
<td>Analysis &amp; Comparison / Relatively Low</td>
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<tr>
<td>Mentorship</td>
<td>Teaching &amp; Retention / Mid-level</td>
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<tr>
<td>Workflow</td>
<td>Often used in industry / High</td>
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<tr>
<td>Interdependent Subsystems</td>
<td>Truest systems approach / Very High</td>
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The majority responded they teach technology but engineering and various science courses also common.

**Figure 1:** Graph representing the pilot teachers’ response when asked what subjects they teach. Total exceeds number of respondents because more than one response was accepted. (N=17)
More than 70% stated that each of the 4 modules was very valuable. All stated that the overview of systems engineering was very valuable.

Figure 2: The number of teachers responding “very valuable” when asked about the value of each of the major workshop activities. (N=18)
Figure 3: The number of teachers stating that their knowledge of each of the listed topics was increased considerably as a result of workshop activities. (N=18)
Results of paired t-test for teacher efficacy in the three focal areas of the workshop (N=16)

<table>
<thead>
<tr>
<th>Pair</th>
<th>t</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Content pre/post</td>
<td>3.955</td>
<td>.001</td>
</tr>
<tr>
<td>Telecollaboration pre/post</td>
<td>3.822</td>
<td>.002</td>
</tr>
<tr>
<td>Engineering pre/post</td>
<td>2.930</td>
<td>.010</td>
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Pilot teachers’ level of confidence increased significantly in all three of the focal areas.
Next Steps

• Conduct Pilot Dec. 2008 – May 2009
• Measure impact on teacher classroom practices
• Refine curriculum modules and disseminate
• Develop online PD
Questions?

For More Info:
www.stevens.edu/ciese/sage

Thank You!