Engineering of Energy Designs: Creativity and Empowerment
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Abstract
This curriculum opens the eyes of practitioners to the vast array of teaching and learning possibilities for classroom application of the Engineering of Energy as well as illustrate how this curriculum and research has been implemented in the US and Uganda, East Africa, and Liberia West Africa. The academic level is suited for undergraduate engineers and professional technicians; however, the astute teacher can easily apply this to other students as we have applied it to US junior energy camps. The Ugandan participants have built large-scale bicycle electric generators, merry-go-round generators, back-up hand crank surgical lamp, hydroelectric generator, incinerator generator, and vertical wind turbines. The US participants have built classroom working devices such as solar powered car with i-pod player, steam engine, and many more devices. During our workshops multiple designs have been executed in groups. Participants leave with a clear understanding of the creativity they possess within themselves and realize the importance of designing these devices.

Participants
The following table is a snap shot of participants and programs this energy curriculum has been involved in after 5 years of making additions to the curriculum:

<table>
<thead>
<tr>
<th>Programs</th>
<th>Status</th>
<th>Number to Date</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISE GISE Summer Camp</td>
<td>US 6th – 8th Grade</td>
<td>90</td>
<td>Empower girls to be engineers or scientists</td>
</tr>
<tr>
<td>Empower Design</td>
<td>Ugandan Technicians</td>
<td>60</td>
<td>Empower technicians to design/build devices</td>
</tr>
<tr>
<td>Empower Design/Technology 4 Tomorrow</td>
<td>Ugandan Engineers</td>
<td>30</td>
<td>Empower engineers to design/build devices</td>
</tr>
<tr>
<td>Mini-curriculum</td>
<td>US K-8th Grade</td>
<td>25</td>
<td>Empower kids to use legs to make electricity</td>
</tr>
<tr>
<td>Lego Energy Camp Spring Break</td>
<td>Liberian Technicians</td>
<td>100</td>
<td>Empower kids for Energy Competition</td>
</tr>
<tr>
<td>Energy for Peace w/ Kofi Annan Institute</td>
<td>Liberian Technicians</td>
<td>30</td>
<td>Create a program throughout the country</td>
</tr>
</tbody>
</table>

We hope to get feedback from this poster presentation so that we can move from qualitative analysis of how the process works to quantitative analysis of how successful this process is.

Curriculum in Uganda and Liberia

Introduction
Human development and electrical energy co-exist seamlessly in high HDI countries where reliability and availability is greater than 99%. In numerous low HDI nations, there is 2-50% electric grid availability with reliability at or below 50% due to load shedding and faults. Around the United States and Europe as well as China, engineers, designers, and engineering students are designing products for “the Other 90%” of the world. Throughout Africa, technical students are only being taught to fix the technology that these engineers design and import to their country (cars, solar panels, etc.). It is time for a paradigm shift.

Transdisciplinary Curriculum
When Dr. Musaazi, Prof. Makanda and Dr. Mechtenberg taught this course, they created a powerful interconnection to real life situations such that innovation and entrepreneurship natural flow from class discourse into the workshop for building and onto the streets for selling these devices. This is leading to an African-based energy textbook

Collaboration
UM – Education + Design Textbook: Electricity Microgrid Simulations
UISSA: Design Build Training
Makeere University: Engineering Manufacturing Piloting devices

Designing and Building
Once learning and empowerment begins, we leave the classroom and go to the workshop and markets. The technicians choose and debate how to built these devices with ALL locally available materials. The key component of this model is the Technology Transfer Table (TTT).

Every part of the working classroom model is written up with the corresponding local materials. For example, the tape becomes welding solder. The plastic gears that are used to change speeds are exchanged for bicycle wheels with belts and pulleys. The plastic structure becomes wood and steel. Look on-line or contact us for videos/pictures or what we have built.

Curriculum in United States

Introduction
These electricity devices are creatively designed within our Lego Energy curriculum. From wind turbines to solar powered vehicles, the students embrace the five essential components to designing energy systems: sources, carriers, converters, storages, and end-uses or devices. We are working within the US curriculum to foster creativity from university-based engineering design coursework to K-12 science camps and competitions. We not only teach science, but we teach it within a science, society and technology (STS) world view.

In the above organization, one can imagine that students learn about the key components of energy systems. What is not obvious is the creativity, excitement, and empowerment which occurs.

In the image to the left, students in 2 hours create and play with their own Lego Sustainable City which includes cars, houses, wind turbines, hydroelectric generators, and solar panels

Collaborators
Faculty: Abigail R. Mechtenberg, Moses K. Musaazi, John V. Makanda, Deby T. Sayndee, William E. Chaver, Paul Clyde
Student: Chelsea Random, Kendra Barnhers, Alex Chang, Farhan Homaici, Akram Sulaiman, Scott Hubert, Victor Braczisowski, David Dunn, Jake Graham, Emmanuel Myriyo, Nancy Senabunya
Institutions: Makerere University, Mountains of the Moon University, Virka Hospital, Homer Energy, Ugandan Small Scale Industry Association. St. Joseph Technical Institute
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