Engineering of Energy Designs: Creativity and Empowerment

Abigail R. Mechtenberg, Debey Sayndee
(amechten@umich.edu, tsayndee@umich.edu)

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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. :

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

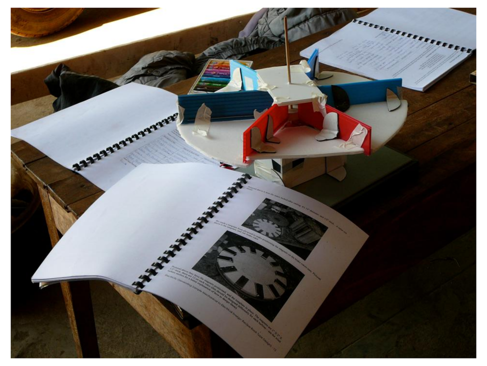
We hope to get feedback from this poster presentation so that we can move from qualitative analysis of how the process works to quantitative analysis of how successful this process is.

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

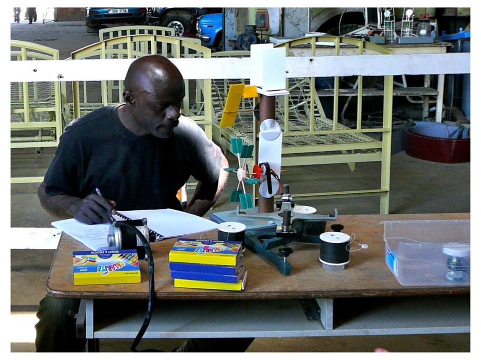
UM – Education + Design Textbook
Electricity Microgrid Simulations

USSIA:
Design
Build
Training

Mountains of The Moon University:
Business

Makerere 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.

Mechanical to Electrical	Light to Electrical	ME or LE to Chemical	Thermal to Mechanical
Sources: Hand, Wind 1, Wind 2, Rain	Sources: Light	Sources: Hand, Wind 1, Wind 2, Rain	Sources: Light Candle-Chemical
Carriers: Electricity - Wires	Carriers: Electricity - Wires	Carriers: Electricity – Wires Fluid – Tubing	Carriers: Electricity – Wires Fluid – Tubing
Storages: Flywheel	Storages: Battery Capacitor	Storages: Hydrogen & Oxygen tanks Capacitor	Storages: Everything
Converters: Motor/Generator	Converters: PV Motor/Generator	Converters: Fuel Cell PV	Converters: Minto-wheel Steam Water Wheel
Devices: Buzzer, Bulb, Fan	Devices: Car or Boat	Devices: House	Devices: Spinning motion

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.

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, Debey T. Sayndee, William E. Chavey, Paul Clyde
Student: Chelsea Random, Kendra Borchers, Alex Chang, Farhan Hormasjii, Akeram Suleiman, Scott Hulbert, Victor Braciszewski, David Durm, Jake Graham, Emmanuel Miyingo, Nancy Senabulya
Institutions: Makerere University, Mountains of the Moon University, Virika Hospital, Homer Energy, Ugandan Small Scale Industry Association, St. Joseph Technical Institute
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