STEM: Explore, Discover, Apply – Engaging Electricity Modules for Middle School (P12 Resource Exchange)

Dr. Krystal S. Corbett, Cyber Innovation Center

Dr. Krystal Corbett is the Director of Curricula at the Cyber Innovation Center (CIC). She received her B.S. and M.S. in Mechanical Engineering (2008/2010), M.S. in Mathematics (2012), and Ph.D. in Engineering Education (2012) at Louisiana Tech University. Through the CIC, Dr. Corbett manages various educational enterprises. Additionally, she is designing and implementing a three-part middle school elective course, STEM: Explore, Discover, Apply, which fosters excitement in STEM.

Sara Hahler, Louisiana Tech University

Sara Hahler is a graduate student at Louisiana Tech University. She received her Bachelor of Science in mathematics education in 2012 from Louisiana College and is currently enrolled in the Computational Analysis and Modeling PhD program at Louisiana Tech. During her time as an undergraduate, she served as a tutor for the mathematics department at Louisiana College. In 2015 she earned her Masters of Mathematics and Statistics from Louisiana Tech. Currently, she is performing research in the area of mathematics education exploring the connection between high school ACT mathematics scores and freshmen mathematic/engineering class grades.
Curricula Summary

Electricity is one of the twelve design module themes from the three course elective sequence STEM: Explore, Discover, Apply (STEM EDA), which is designed for middle school grades 6-8. STEM EDA provides engaging STEM curricula through the lens of engineering design while also fostering skills like teamwork, communication, problem solving, and critical thinking. In addition to increasing in difficulty and depth of concepts covered, each level of the curricula (Explore - 6th grade, Discover - 7th grade, and Apply - 8th grade) has a different context and scenario-based design challenge.

The electricity modules supply structure for teaching fundamental principles associated with electricity in an engaging and non-intimidating manner for both teachers and students. Using the **engineering design process** as a guide, students are able to address and apply concepts related to electricity as well as build competencies in problem-solving. The content is presented as cross-curricular to help students see connections with various disciplines which provides more meaning and purpose to the STEM content they are learning. These lessons build foundational skills at the middle school level for students that may pursue engineering careers such as electrical, mechanical, industrial, and computer engineering.

Summary of Electricity Modules

<table>
<thead>
<tr>
<th>Level</th>
<th>Design Challenge</th>
<th>Research Topics/Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explore</strong></td>
<td>Students work in teams to design a working illumination system out of common materials and circuitry components during a blackout caused by cyber attackers.</td>
<td>cyber attacks, atoms, electrons, neutrons, protons, conductors, insulators, batteries, electrochemical energy, cathode, anode, build homemade batteries, voltage, multimeters, circuits, series circuits, parallel circuits, Kirchhoff’s Voltage Law, switches, and flashlight components.</td>
</tr>
<tr>
<td><strong>Discover</strong></td>
<td>Students build a working telegraph and encode messages that are sent as if they were in Civil War times working for Military Telegraph Corp. They will also have to intercept messages from other groups telegraphs and decode the intercepted encrypted message.</td>
<td>electricity, magnets, electromagnetism, build a Beakman motor, circuitry, Morse code, cryptography, develop codes, decipher codes, civil war, and history of codes in wartime.</td>
</tr>
<tr>
<td><strong>Apply</strong></td>
<td>Students are challenged to use various electrical components like DC motors, vibration motors, LEDs, resistors, and switches to design and build an interactive electronic game. Additionally, they have to develop a business plan for bringing their game to market.</td>
<td>atoms, free electrons, current, voltage, elements, periodic table, proportions, conductors, insulators, build circuits, power sources, LEDs, resistors, switches, motors, games types, game design, develop mind maps, business plan, and cost analysis.</td>
</tr>
</tbody>
</table>

Curricula Access

All curricula materials are hosted online for ease of distribution to teachers across the country. Teachers and other K12 personnel can obtain access (at no cost) to full teacher’s manuals, student workbooks, and various other resources at: www.NICERC.org/curricula/curriculaccess.

Curricula Implementation

The robust nature of the electricity modules provide three weeks of content for a class meeting one hour every day. However, components of the modules could be extracted to illustrate a single concept (e.g., building simple circuits). Schools can implement the modules in a variety of ways: as an elective, after school program, or inserted into their existing classes.
K12 & Precollege Division Resource Exchange

At the resource exchange, participants will interact with various mini-projects found throughout the modules that illustrate the electricity concepts. Additionally, participants will see final design project examples as well as peruse the full teacher manuals and workbooks for the three electricity modules described. Due to depth of modules, full versions cannot be included in this document. However, they will be available at P12 Resource Exchange. Screenshots of various pages within the modules are given below to provide an idea of the look and feel of each module.

**Explore** (module length 63 pages):

**Discover** (Module length 106 pages):

**Apply** (module length 75 pages):