HOW MUCH FUN CAN WE MAKE WITH ELECTRICITY? (GRADE 6)

OTTO WEVERS (/USERS/OTTO-WEVERS)

Students will be using their prior learned knowledge of electricity and electrical circuits to design and build a “fun moving” electrical circuit that can be powered by a single “D” or “C” cell battery. The project will guide them to create an inquiry around the minimum and maximum complexity their battery will be able to power. (They will describe what “fun movement” can be provided by the conversion of electrical energy from the battery into other forms of energy.)

Grade Level/Course Code: Grade 6

Strand(s) and Unit(s): Understanding Matter and Energy: Electricity and Electrical Devices.

Inquiry Focus:

Key Words: Electricity, current, resistor, energy, switch, conductor, motor, generator, resistance, voltage

Key Questions: How can electrical energy be controlled and converted into other forms of energy?

Is there a relationship between the electrical energy available and the other amounts and/or energy it can be converted to?

Timeline:

2 weeks for teaching prior skills and knowledge 100 min/week plus 75 min reading and writing literacy time. See prior knowledge and skills. Approximately 4 lessons

2 weeks for design, build, inquiry and rebuild. 100 min/week plus 100 min writing report and media presentation literacy time

See Inquiry instructional planning and delivery table for details.

Prior scaffolding skills

Lesson 1:

Observation of effects of static and current electricity and the importance of a complete circuit for current electricity. Safety associated with electrical circuits as needed. See STAO’s Safety in Elementary Science and Technology Curriculum, A Reference guide for Elementary School Educators, especially Section 4.2.3 and 4.34

Lesson 2:

Observation and inferring how the conductors and insulators act in a circuit (hands on activity). Learning how to use Explorelearning.com gizmos and following student work guide for independently (Circuit BuilderSE.doc from explorelearning.com)

Lesson 3:

Identifying and describing energy transformations through resistors like lamps and motors and how to connect build circuits including making a simple toggle switch.

Knowledge- building lessons.

Lesson 1:

Introduce electricity as static or current with some examples of each as a concept attainment lesson. Can make this part of your nonfiction writing literacy time by asking students to write descriptive observations of electrical phenomena.

Lesson 2:

Electrical conductors and insulators hands on investigation in class and IT circuit gizmo to be completed in part at home with parents. Can make this part of your nonfiction reading literacy time, following written instructions by completing the CircuitBuilderSE.doc and related Gizmo from explorelearning.com

Lesson 3:

Current electricity can be converted to different forms energy through various resistors and motors hands on activities. Use EnergyTransformationsSE.doc and related Gizmo from explorelearning.com for reading literacy or homework to reinforce energy transformations on large scale.

Lesson 4:

Making circuit diagrams, using various examples from prior lessons. See file: gr 6 Elec symbols for circuits.doc for common circuit symbols.

Inquiry Activity:

Big Ideas:

- Energy can be converted into different forms
- Electrical energy (in a battery) is a limited resource
- Electrical circuits use electrical energy in various amounts that depend on the resistance created by the energy transformations
- Fun is a subjective term, and is not a science big idea, but is a big value idea in technology

Overall Expectations:

1. Evaluate the impact of the use of electricity on both the way we live and the environment;
2. Investigate the characteristics of static and current electricity, and construct simple circuits;
3. Demonstrate an understanding of the principles of electrical energy and its transformation into and from other forms of energy.

Specific Expectations:

2.1 follow established safety procedures for working with electricity (e.g., ensure hands are completely dry when working with electricity; be aware of electrical hazards at home, at school, and in the community)

2.2 design and build series and parallel circuits, draw labelled diagrams identifying the components used in each, and describe the role of each component in the circuit

2.4 design, build, and test a device that produces electricity

2.5 use technological problem-solving skills to design, build, and test a device that transforms electrical energy into another form of energy in order to perform a function

2.6 use appropriate science and technology vocabulary, including current, battery, circuit, transform, static, electrostatic, and energy, in oral and written communication

2.7 use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes

3.4 describe how various forms of energy can be

transformed into electrical energy (e.g., how an electric motor can also be an electricity generator)

3.5 identify ways in which electrical energy is transformed into other forms of energy (e.g., electrical energy is transformed into heat energy, light and sound energy, mechanical energy)

3.6 explain the functions of the components of a simple electrical circuit (e.g., a battery is the power source; a length of wire is the conductor that carries the electrical current to the load; a light bulb or motor is the load)

Expectations from Language and Mathematics:

Language: Reading

OA 1. read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning;

SE 1.3 1.3 identify a variety of reading comprehension strategies and use them appropriately before, during, and after reading to understand increasingly complex texts

Language: Writing

OE 2. draft and revise their writing, using a variety of informational, literary, and graphic forms and stylistic elements appropriate for the purpose and audience;

SE 2.5 identify their point of view and other possible points of view; determine, when appropriate, if their own view is balanced and supported by the evidence; and adjust their thinking and expression if appropriate

Language: Media Literacy

OA 3. create a variety of media texts for different purposes and audiences, using appropriate forms, conventions, and techniques;

SE 3.2 identify an appropriate form to suit the specific purpose and audience for a media text they plan to create, and explain why it is an appropriate choice

SE 3.3 identify conventions and techniques appropriate to the form chosen for a media text they plan to create, and explain how they will use the conventions and techniques to help communicate their message

Mathematics: Data management and probability

OE 1. collect and organize discrete or continuous primary data and secondary data and display the data using charts and graphs, including continuous line graphs;

SE data relationships: read, interpret, and draw conclusions from primary data (e.g., survey results, measurements, observations)...

compare, through investigation, different graphical representations of the same data...

Key Concepts: Electricity is one form of energy and can be converted into other forms of energy

For electricity to be converted into another form it must be able to flow through a complete circuit made up of at least a power source, a switch, conductors and a resistor.

Electricity can be converted from mechanical energy in a generator or stored as chemical energy in a battery.

Prior Skill Sets:

Students should be able to:

- Construct complete circuits with energy source, conductors, resistors and switches,
- Strip wire using a wire stripper,
- Make good conducting connections
- Make a switch to control a circuit
- Be able to fasten various materials as required

Prior Knowledge:

A good primer on electricity for grade 6 teachers can be found at: http://teachersinstitute.yale.edu/curriculum/units/1989/7/89.07.01.x.html (http://teachersinstitute.yale.edu/curriculum/units/1989/7/89.07.01.x.html) as both a series of knowledge and activities to help teach and learn about electricity. You only need to read the narrative sections to get a pretty good overview. There are also some good teaching activities you might want to consider doing yourself and with your students. Don't let the date fool you. This is a well developed and still relevant resource.

Students should be able to:

- Make electrical diagrams showing energy source, conductors, resistors and switches.
- Explain that energy can be converted from one type of energy to another through a machine (this is also part of grade 4 and grade 8 fundamental scientific knowledge about the concept and forms of energy).

Materials and Equipment:

Material resources:

- D or C cell batteries,
- wire (broken cat 5 internet cables are perfect)
- 1-1.5V
- motor
- cams
- pulley wheels
- gears
- paper clips
- paper connectors
- shoebox or similar size conatainers
- cardboard or Coroplast (plastic cardboard, many election signs are made of this)
- various found materials Found materials may come from home in adequate quantities and safety checked by teacher for class use such as low voltage Christmas LED lights, Meccano or other similar building toys, used coffee tins...

Equipment Resources:

- Volt meter for testing batteries
- continuity tester for testing batteries and troubleshooting circuits
- A static electricity kit: wool, acetate, plastic cylinder, pvc tube, nylon comb (some school boards have these available as a kit. If your board doesn't, try to get them to consider doing it).

These are suggestions but not required for teaching: Energy stick https://stao.ca/cms/en/stao-store/products-catalogue/steve-spangler/energy-stick (https://stao.ca/cms/en/stao-store/products-catalogue/steve-spangler/energy-stick) as a continuity tester/whole class experiment, hand generators (kit from Kidder Plastic https://kidder.ca/hand-generator-kit-20-student-class-pack.html (https://kidder.ca/hand-generator-kit-20-student-class-pack.html) or complete from Arbor https://www.arborsci.com/hand-crank-generators.html (https://www.arborsci.com/hand-crank-generators.html) or other suppliers).

Measuring and building equipment

- Timer
- hand generator
- wire cutter/stripper
- various tools as needed for shaping and connecting.

IT resources

- Gizmos from Explorelearning.com:

1. Energy Conversions
2. Circuit Builder

- Google's GAfE suite for communicating and recording in a variety of ways

Safety:

- Battery: 1 C or D cell, not in series! Criteria: No burns or overheated batteries.
- Cutting, shaping and connecting tools safety. Criteria: No cuts, burns or abrasions, safety glasses used when possibility of projectiles.
- Clean and tidy storage of project. Criteria: Project is in shoebox or similar size storage nothing loose left on floor or desks.
- See STAO's Safety in Elementary Science and Technology Curriculum, A Reference guide for Elementary School Educators in general. See especially Section 4.2.3 and 4.34 for building and electrical safety.

Instructional Planning and Delivery:

Time	Lesson content and prompts	Teaching Suggestions	Materials and resources

10-15 min	Bring in a fun battery operated electrical toy, the older the better, and use a show and tell format to generate interest.	Thrift stores or garage sales are good places to find these. Demonstrate it and explain why you think it is fun in a whole class setting (think aloud modelling). This is also a model for how they could be doing a similar presentation with their toy!	Electric toy or game. Operation "the whacky doctors game, batteries not included." Is fun.
15 min	Describe the final energy conversion (sound, light, movement) that makes the toy fun and then trace it back to the switch and battery.	Orally intuit the circuit especially if you can't see all of the electrical parts of the toy (model the "think aloud" teaching strategy)	
10 min for diagram 15 min for sharing in groups	Ask students to make a circuit diagram of your toy. Have them compare and contrast their diagrams in small groups and make corrections where needed.	Encourage the possibility of some diversity in diagrams as long as it is a complete circuit. This is your check to see if they fully understand a circuit in a novel situation (pretest and peer mediated consolidation).	Small whiteboards or Paper &Pencil (P&P) or with wires and symbols
10 min and home-work	Challenge them to individually design and make a fun electrically operated toy using a motor, wires, a cam, gear or pulley wheel as a starting point.	Have them trace their energy conversions design idea back to the battery as you did so they can intuit that a circuit is needed to make it work.	1.5V Electric motor, cams, pulley wheels and gears.
10-20 min	Hand out and go over the gr 6 elec toy student.doc file to set the stage and allow students to have an anchor to the requirements of the inquiry.	You could also create your own rubric with students or use the one provided so kids know pretty well what is expected.	Student activity sheet and rubric

Home-work	Find and bring a shoebox or similar for storage and identification of potential materials to begin the process of building and inquiry.	I allow any kind of safe material from home as long as it is passed by me and also made available to everybody else in the class. (Equity and safety in construction materials)	Student found, teacher checked materials
ongoing	Make a location available for shoebox storage. Begin the process of the routines needed to: get materials, build, test, rebuild, clean up and put away.	It is helpful to have 1 or 2 students manage materials, manage organizing storage to free you up for observation and assistance.	Place for student project storage and access routines for materials and tools
2-3 hours over a week	▪ : assist and direct as needed for first round of build. Use the gr 6 elec toy student.doc activity sheet and rubric to guide their thinking and ongoing inquiry	Safety teaching/review of tools. Assessments as and for learning on as needed basis. Help students overcome technical problems with implementation and troubleshooting where and when needed to overcome technical roadblocks.	Hot glue gun, cutting and shaping tools

• : Observe, assist and direct as needed for first round of build..	I found it useful for many students to have them make a circuit with the generator/battery and motor and cam, gear or pulleywheel before adding anything else. This way it gave quick success and a place to always fall back to for troubleshooting. Then start to add other components like the switch, other resistors. Small hand generators were very useful here instead of burning through batteries and having to check if batteries were discharged or not.	Hand generators, • Materials and tools for building.
▪ : How complex can you make the toy for the battery energy you have?	During adding complexity to their toy they are now doing their inquiry. Help them recognize that they are doing inquiry and record their thoughts, observations and trials using the language planning required of inquiry: hypothesis, variables, controls, measurements, observations data, results and conclusions.	Student created plan for inquiry and observation charts

	◦ : Why is your toy fun? Who would your toy be the most fun for? What did you learn about yourself? What did you learn about electricity from making this toy?	A gallery walk of the toys is a great way to see diversity of what kids think is fun. Inviting other classes in to see the toys is also a nice way to acknowledge the work and thought that went into making the toys.	Materials and resources as needed for making presentation
Max 2 min/ student	Deliver a presentation to class about toy and inquiry findings	Presentation can be in any format. Live in class, video, poster display, PPT/Prezi, GAfE...Assessment of learning when presenting their toy.	

Student Support Resources:

gr 6 Elec symbols for circuits.doc

gr 6 elec toy student.doc

gr 6 elec assess of rubric.doc

Related Background Resources and/or Links:

Leslie Chiswell, John Goodyear, Christer Nilsson, STAR Electricity. GTK press, 1999, http://www.gtkpress.com/electricity (http://www.gtkpress.com/electricity)

https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&resourceID=638 (https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&resourceID=638) Circuit Builder Gizmo, accessed July 23,2018

https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=651 (https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=651) Energy Transformations Gizmo, accessed july 23, 2018.

Assessment Opportunities:

Safety: Observe and record safety practices by students using the tools and materials.

Inquiry **assessment of learning**: Use rubric provided, or create rubric with students to make assessment as guiding and transparent as possible.

Inquiry **assessment for learning**: descriptive feedback, especially when testing components out and troubleshooting circuits.

Inquiry **assessment as learning**: Use rubric provided to create one point rubrics that have student self reflect on inquiry process and effectiveness of learning about electricity this way.

Future Opportunities / Extensions:

I suggested that those who have a bit of an entrepreneurial bent could make a presentation to Dragon's Den program on the CBC. They do a kids version from time to time.

These toys are wonderful components for a STEM (or STEAM) family evening because they are interactive and give kids something in their hands to talk about.

The project is also a good opportunity to talk about the electrical trade, electrical engineering, and what knowledge and skills to carry forward to grade 8 in the work and energy strand.

WATCH THE VIDEO
02:03 min

(//www.youtube.com/embed/OqPlfLySCgQ?width=800&height=450&iframe=true)

RESOURCES

- teacher electricity backgrounder (http://teachersinstitute.yale.edu/curriculum/units/1989/7/89.07.01.x.html)
- Gizmo "Circuit Builder" (https://www.explorelearning.com/index.cfm)
- Gizmo "Energy Transformations" (https://www.explorelearning.com/index.cfm)
- STAO's on line safety learning modules (https://stao.ca/cms/en/safety-mindedness)
- Electric toy rubric (https://connex.stao.ca/sites/default/files/gr_6_elec_assess_of_rubric.doc)
- Electrical symbols for use in circuit drawing making (https://connex.stao.ca/sites/default/files/gr_6_elec_symbols_for_circuits.doc)
- Student project handout (https://connex.stao.ca/sites/default/files/gr_6_elec_toy_student.doc)
- Complete teacher outline (https://connex.stao.ca/sites/default/files/grade_6_electricity_inquiry.doc)

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