CURRICULUM PROPOSAL + MATERIALS

UNIT 2: Matter + Energy

Standards-aligned across
NYS middle school
Science and Social Studies

Draft 2 for IS 421
August 10, 2011

MFA D+T PARSONS THE NEW SCHOOL FOR DESIGN

August 10, 2011

This curriculum and its appendices were designed in an Intensive MFA Design+ Technology Collaboration Studio in the summer of 2011. Please note that the original curriculum is yet untested with children. We would very much like to participate in testing in the coming school year. The entire packet is specifically tailored for 7th Grade Science at the *Youth Voice Through Youth Media* Magnet Middle School in New York City's District 3. Please note that the school has been in existence for two years as I.S. 421, West Side Prep, and is repositioning itself and moving to a new location to reopen as the magnet school in fall 2011. Our interpretation of the Magnet Theme is at the foundation of our Curriculum Project Design (please see the diagram on page 2.) We assume that *Youth Voice* at the school will be manifested in what the students make across the curriculum, ranging from written poems to completing the physical computing projects detailed in this packet. The *Youth Media* will be ever present as the students document and present their work, a process also detailed below.

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Presentation Instructions
We believe that presentation (whether as a public presentation or blog post) is important to students understanding and caring about their work. Optimally, each project should end with each group displaying their results. This document provides more defined instructions for how students should structure each of their presentations.

Unit 2 Lesson Outline
This mentions all of the projects we've designed and give a short synopsis/context for each.

Materials List
Listed here are the materials needed for each project (organized by project).

Project Documents
This section of documents discusses each of the projects in detail. It gives context, learning outcomes, and procedures for each project. We've organized these all in a similar manner, but can reorganize them based on a different lesson plan structure, ifprovided with an example.
Projects listed are:

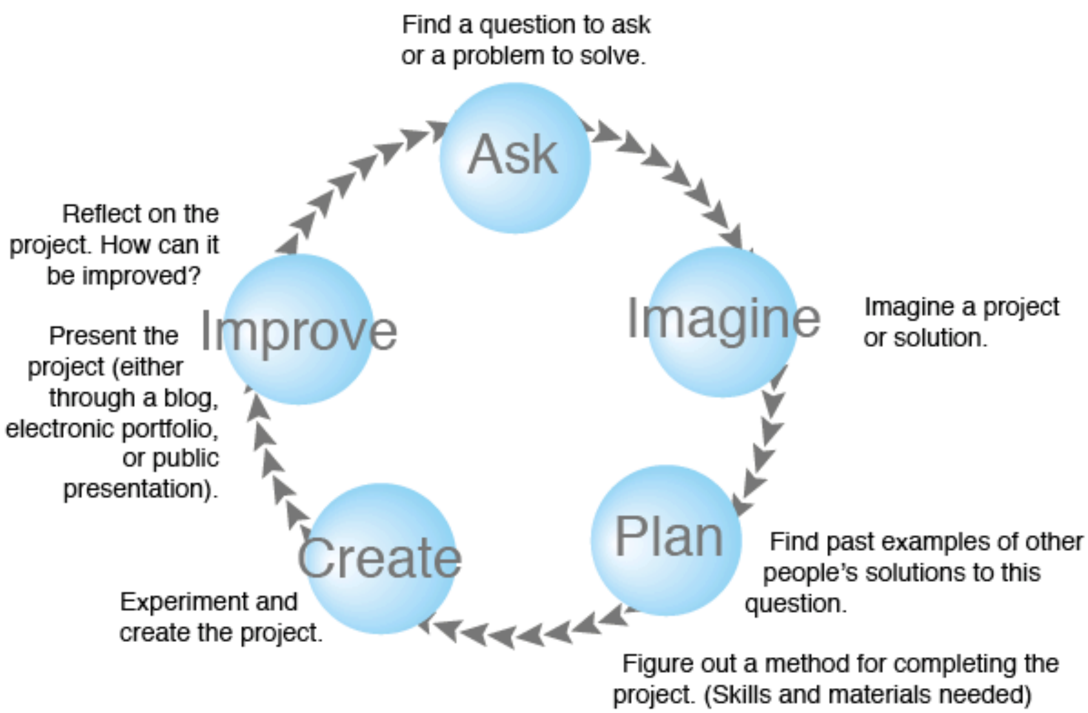
Electronic Portfolios in the Classroom
This document provides some research for the use of electronic portfolios. We believe this is a valuable tool for students, because it allows them to keep a record of the work they've done. Additionally, if a project is completed but there isn't time for each group to do a public presentation, a blog post can take its place.

Design Process
This document provides a visual and written explanation for each step in the design process.
(Separate document)

Scientific Method
We'd like to provide the students with visual procedures that can be followed with all of the projects we've provided. The process we'd like them all to think about when completing their projects is a cross between the traditional scientific method and the design process. This document provides different visual representations of the scientific method.
(Separate document)

PRESENTATION INSTRUCTIONS

The Design Process



ASK	Find a Question to Ask (The Assignment)
IMAGINE	Imagine a Project or Solution
PLAN	Find Past Examples of Other People's Solutions to this Question
	Figure Out How The Student Will Answer this Question (Could be simply reading and understanding the assignment instructions)
CREATE	Experiment and Create their Project
IMPROVE	Reflect on Their Project, How Can They Improve It
	Present Their Project

Please see the attached documents DesignProcess.pdf and ScientificMethod.pdf for a breakdown of the diagram.

Documentation Guidelines

The individual or team of students should engage in documentation throughout each project. They can collect reference visuals, draw, and take pictures and/or short videos, with captions noted in text or audio, on each new step and its outcome. Failed steps or projects are as important as successful ones and should be documented and reflected upon in the same way.

In the beginning when learning documentation methods, these pictures/videos can be organized by the corresponding stage in the design process. Later when the design process is well understood, student can be given more flexibility in organizing their presentations.

While the students should be encouraged to collect and take many pictures and videos during their process, they will ultimately only use between 7 – 15 pictures, and videos should typically be no more than 30s – 1 minute long. This process of self-editing will be improved as the semester goes on, as students understand what is necessary to communicate to others during the presentation. Students can use powerpoint or keynote for their presentations.

In a team students should self-organize, with guidance from the teacher if necessary, to take on specific roles to complete the project. One such role could be "reporter" or "documentarian".

Presentation Guidelines

The student's presentation should explain the path followed to complete the project. It should be a combination of written documentation and reflection, photographs, and videos.

Depending on the project or assignment, the presentation will take the form of either a blog post, Electronic Portfolio entry, or public presentation. In the case of a written presentation (blog post or EP), the following questions should be answered in writing with pictures and videos to supplement. In the case of a public presentation, there should be a photograph for each step, and the students can choose to talk through their answers or post slides with the answers. Additionally, a teacher may choose to require both formats, or a written component in addition to the public presentation.

Please address the following questions in your presentation:

- What problem did you solve, or question did you ask with your project?
- How did you propose to solve or answer this question?
- What past examples did you find? This section should include pictures of the other projects, a 2 – 3 sentence explanation, and a link to the projects website. What other research did you do?
- What was your proposed method? Did you follow a tutorial? Did you write your own steps? Did you have to learn any new skills to complete the project? What materials did you have to use?
- Please provide a written description, photographs, and a short video of your finished piece.

- Was your project successful? Did it solve the problem or answer the question you asked at the beginning?
- What would you change if you could do the project again?

Additionally, teachers can choose to add any questions they wish to this list.

UNIT 2: MATTER AND ENERGY

LESSON OVERVIEW + STANDARDS ALIGNMENT

The projects below are design to build upon one another, but can be rearranged or subtracted based on the discretion of the teacher. The projects have been designed to work around the idea of a Student Toolkit*, specifically referenced in the first project. However, this focus can be deleted by simply providing the students with the required materials for each project and skipping the first project.

Student Toolkit

A group of tools and materials curated by both the student and teacher. These tools and materials are used to complete each project, and the inventory is added to with each project. This represents the education the students are adding to as they go throughout school, and prepares them with the knowledge that objects and education modules can be learned again and again to solve different problems.

LESSON TOPICS	MAGNET HEADER	SPECIFIC STANDARD	PROJECT SUMMARY
1) Introduction to Scientific Inquiry: Materials, Toolkits, and Documentation	Analysis, Inquiry, and Design (Standard 1)		Students will be introduced to the fundamentals of the design process as a method of scientific inquiry. They will learn the importance of documentation and materials analysis as they begin building the toolkit of materials and objects they will use over the course of the unit. This lesson will set the established expectations of documentation for the projects throughout the unit.
2) Creating an Electromagnet	Properties of Sound and Light	Electromagnet energy PS 4.1d; PS 4.4a	Students will follow instructions on how to build an electromagnet. They will then brainstorm other materials that could be substituted for the generic ones they all used, and other applications of their magnet. Why it is good to have a magnet that can be turned on/off. The students will then document the process of building their magnet, and present their completed version to the class. The documentation should include: photos, videos, short written descriptions, and a finished presentation in Powerpoint (or Keynote) and blog post. During the presentation, they will discuss the alternatives that could have been used in the project.
3) Making a Styrofoam Speaker	Wave Behavior	Vibrations and sound waves	Students will follow instructions on how to build a Styrofoam speaker. They will then brainstorm

		PS 4.4c	other materials that could be substituted for the generic ones they all used. Students will discuss how this project helps them to understand sound, and the way commercial speakers work. The students will then document the process of building their speaker, and present their completed version to the class. The documentation should include: photos, videos, short written descriptions, and a finished presentation or blog post. During the presentation, they will discuss the alternatives that could have been used in the project and the way this project applies to a commercial speaker.
4) DIY Infrared Digital/Pinhole Camera	Wave Behavior	Light reflection and refraction PS 4.4b	Students will make their own cameras, paper, and cyanotypes. Through this process, students will learn about light and refraction, and its affect on light sensitive paper. After finishing their printed photos, students will discuss both the process of creating the image as well as the subjects of their images.
5) Squishy Circuits	Properties of Matter Physical and Chemical Changes	The properties of materials such as: density, conductivity, magnetic materials, and solubility PS 3.1a Characteristics of physical changes PS 3.2a Mixtures and Solutions PS 3.2b Temperature and its effects on solubility PS 4.2e Characteristics of chemical changes PS 3.2c,d	Students will make their own conductive and insulated play dough, then construct circuit sculptures out of them. After students have working circuits, they should then design a squishy sculpture based on a chosen theme. Students should be encouraged to test numerous configurations as a means of exploring the conductive and physical properties. They should actively document the process in the form of images, video, written descriptions, etc. At the end of the projects, students will have to present their sculpture for a class critique in which they articulate the aim of their project, explain their process, and receive feedback. Final presentations will be uploaded to the class blog.
6) Fabric Printed Circuit Board	Properties of Matter Physical and Chemical Changes	The properties of materials such as: density, conductivity, magnetic materials, and solubility PS 3.1a Elements and compounds PS 3.3e,f Atoms and Molecules PS 3.3a-d Characteristics of physical changes PS 3.2a	Printed circuit boards are integral to technology that students use everyday. Printed circuit boards are used for final design iterations. This means that you have already tested your circuit, know that it works, and it fits into the object you are designing. In this project, students will conduct a controlled experiment in which they make a fabric printed circuit board. Using copper fabric, masking tape, resist (vaseline), salt, and vinegar, students create a chemical reaction that removes the copper from the fabric, leaving only traces to connect the circuit components. Through this experiment students will apply their knowledge of mixtures and compounds, chemical reactions and properties, basic circuits,

	Understanding Chemical Reactions	Mixtures and Solutions PS 3.2b Characteristics of chemical changes PS 3.2c,d Energy changes in chemical reactions PS 4.3a Law of Conservation of Energy PS 4.5a,b Interactions among atoms and/or molecules result in chemical reactions PS 3.3d	and design. Students should be familiar with chemical reactions and the basics of circuitry.
7) Creating Paper with Embedded Lights	Properties of Matter Physical and Chemical Changes	The properties of materials, such as: density, conductivity, magnetic materials, and solubility PS 3.1a, b, g, h; PS 4.4 f, g Characteristics of physical changes PS 3.2a Temperatures and its effect on solubility PS 3.1b; PS 4.2e	Students will follow instructions on how to make paper with an embedded LED. They will then brainstorm other materials that could be substituted for the conductive ones they used. What are other electronics they could have or would have liked to embed in the paper? Students should discuss how embedding electronics within paper could change paper use and computer use in the future. The students will then document the process and present their completed version to the class. The documentation should include: photos, videos, short written descriptions, and a finished presentation or blog post. During the presentation, they will discuss the alternatives that could have been used in the project.

MATERIALS LIST

All materials are listed below per project. For attaining the amount needed for a classroom, teachers should first decide what group size is optimal (we designed the projects with groups of 3-4 students in mind). Multiply the number of groups with each material's number, specified below, to determine quantities to be purchased.

PROJECT 1: Electromagnet

- 1 iron nail 6 inches long (a steel screw/nail can be substituted, but the magnetism will not be as strong) purchase at home depot or other hardware store
- 10 feet 22 gauge insulated stranded or solid copper wire
- one or more D-cell batteries
- a pair of wire strippers

PROJECT 2: Styrofoam Plate Speaker

- 1 styrofoam picnic plate
- 1 sheet of regular copy paper
- 2 business cards (or cut up sheet of thicker paper
- copper wire (or magnet wire), 32 gauge enameled, 1 roll per group
- scotch tape
- glue gun
- 1 small neodymium cylinder magnet
- flat piece of wood or cardboard (should be larger than the plate)
- audio plug (1 per 2 groups)
- 2 alligator clips

PROJECT 3: Squishy Circuits

Part I

For the class:

- 5lb bag of flour
- 1lb box of sugar
- 1 bottle of vegetable oil
- 2 1.5oz jars of Cream of Tartar
- 1 canister of table salt
- 1 gallon distilled water
- food coloring (set of four)

Per group:

- medium-sized pan
- stove top burner

- plastic spoon to stir with
- measuring devices (graduated cylinders, beakers, etc)
- small plastic bags (for storage)

Part II
(Assuming approx 20 students)
- 40 LEDs (These are extremely cheap LEDs that you can only purchase in bulk):
  - Red LEDs
  - Blue LEDs
  - Green LEDs
  - Yellow LEDs
- 10 multimeters (one per group or groups can share)
- 10 9 Volt batteries and holder
- Conductive and Resistive play dough from the previous lesson

PROJECT 4: Fabric Printed Circuit Board
Part I
- Project Kit per student (assuming 20 students):
  - 3x3" square of pure copper polyester taffeta fabric
  - 1 LED (or 2 if you want to continue working on parallel and series circuits) - use the LEDs from the previous Squishy Circuits project!
  - 220 Ohm resistors
  - two 3 Volt batteries
- Masking tape
- Alligator clips

Part II
- Copper fabric with masking tape *(from previous class)*
- Vaseline
- Salt

Part III
- Etched fabric printed circuit board and solution (from prior class)
- Project kit (from prior class)

PROJECT 5: Creating Paper with Embedded Lights
- old paper to use (or cardstock, but make sure it is not coated or glossy)
- window screen cut to approximately 4 x 6 inches (or desired size of paper) for paper
- tub to put pulp/water in
- blender to create pulp

- conductive thread
- LEDs
- 3v battery(also available at ikea for $1 per pack of 10)
- conductive materials to experiment with conductive paths within paper such as:
    - 22 gauge non-insulated wire
    - string of paperclips
    - an old metal chain necklace
    - twisted tinfoil
    - *get creative!!*

PROJECT 1: Creating an Electromagnet

Grade 7, Unit 2

Materials

- 1 iron nail 6 inches long (a steel screw/nail can be substituted, but the magnetism will not be as strong) purchase at home depot or other hardware store
- 10 feet 22 gauge insulated stranded or solid copper wire
    - http://www.radioshack.com/product/index.jsp?productId=2049738
- one or more D-cell batteries
    - http://www.amazon.com/Duracell-Batteries-Size-8-Count-Packages/dp/B001F0RCO6/ref=sr_1_3?ie=UTF8&qid=1308839150&sr=8-3
- a pair of wire strippers
    - http://www.amazon.com/Klein-1011-Stripper-Cutter-Stranded/dp/B0000302WM/ref=sr_1_2?s=electronics&ie=UTF8&qid=1308839196&sr=1-2

Essential Questions/Guiding Questions

- What is a circuit?
- What is electromagnetic energy?

Enduring Understandings

- How does energy travel?
- What is the relationship between an electric field and a magnetic field, and how do they form electromagnetic energy?
- How is an electromagnet different from a static magnet?

Unit Rationale

The students will learn about circuits and energy. In this first section they will specifically explore electromagnet energy and build their own electromagnet.

- http://missionscience.nasa.gov/ems/02_anatomy.html

Culminating Projects and Assessments

Students will follow instructions on how to build an electromagnet. They will then brainstorm other materials that could be substituted for the generic ones they all used, and other applications of their magnet. Why it is good to have a magnet that can be turned on/off? The students will then document the process of building their magnet, and present their completed version to the class.

The documentation should include: photos, videos, short written descriptions, and a finished presentation in Powerpoint (or Keynote) and blog post. During the presentation, they will discuss the alternatives that could have been used in the project.

Other Assessments:

- Does the electromagnet work? If not, can they explain why?
- Presentation skills, did they document their process and present the project well?
- Documentation: Does it reflect the project in the best possible way? How could it be improved?

Knowledge

Science: current, energy, electricity, magnetism

Skills

- How to construct a circuit.
- How to document their project.
- How to use a combination of the design process/scientific method to solve a question/problem.
- How to use wire strippers.

Standards

- Electromagnetic Energy PS 4.1d PS 4.4a

Resources

- http://education.jlab.org/qa/electromagnet.html

Lesson Overview & Lesson Plans

Final version will be a pdf including instructions and pictures, based in part on the below link and materials.

Required Materials

- http://education.jlab.org/qa/electromagnet.html
- One iron nail 6 inches long
- 10 feet 22 gauge insulated stranded copper wire
- one or more D-cell batteries
- a pair of wire strippers

Process

1. Form groups and examine the materials needed for the project. Make sure to document the following steps through the use of photography, videography, and especially note taking. You will use this documentation in your individual blog posts.

2. Use the wire strippers to remove some of the insulation from both ends of the copper wire.
3. Neatly wrap the wire around the nail. The more wire you wrap around the nail, the stronger your electromagnet will be. Make certain that you leave enough of the wire unwound so that you can attach the battery. Make sure that you wrap all of the wire around the nail in the same direction. (The direction of a magnetic field depends on the direction of the electric field forming it.)
4. Attach one side of the wire to the positive terminal of the battery, and attach the other side to the negative side of the battery. Your magnet should now be working.
5. Reverse which sides of the wire are connected to which terminal of the battery. Note what has changed. (The polarity [north/south] of the battery.)
6. Experiment with different ways of wrapping the wire (how many turns of the wire around the nail) and note the differences this has on your magnet (it should affect the strength).
7. Experiment with different cores (just make sure the material can be magnetized). To test if the material you want to use as a core can be magnetized, see if it is attracted to your standard static magnet.
8. For homework: Write a blog post detailing your project. Discuss the process you went through, any experimentation you did, and the results you saw. Be sure to post pictures and videos. If anything didn't work the way you thought it would, be sure to note this and why. (For example, if you wrapped the nail in two different directions and it didn't work, please note that this was because the two forces were canceling each other out).

PROJECT 2: Creating a Styrofoam Plate Speaker

Grade 7, Unit 2

Materials:

- 1 styrofoam picnic plate
- 1 sheet of regular copy paper
- 2 business cards (or cut up sheet of thicker paper
- copper wire (or magnet wire), 32 gauge enameled, 1 roll per group
- scotch tape
- glue gun
- 1 small neodymium cylinder magnet
- flat piece of wood or cardboard (should be larger than the plate)
- audio plug (1 per 2 groups)
- 2 alligator clips

Essential Questions/Guiding Questions

- What is a circuit?
- What is a speaker and how does it work?
- How does vibration form sound?
- How does energy travel?
- How does sound travel?
- How does the speaker incorporate what was learned while building an electromagnet?

Enduring Understandings

- Simple vibrations form the sounds we hear everyday.

Unit Rationale

The students will continue their learning about circuits and energy. In this section they will specifically explore sound waves within connection to a magnet by building a speaker.

Culminating Projects and Assessments

Students will follow instructions on how to build a Styrofoam speaker. They will then brainstorm other materials that could be substituted for the generic ones they all used. Students will discuss how this project helps them to understand sound, and the way commercials speakers work. The students will then document the process of building their speaker, and present their completed version to the class. The documentation should include: photos, videos, short written descriptions, and a finished presentation or blog post. During the presentation, they will discuss the alternatives that could have been used in the project and the way this project applies to a commercial speaker.

Other Assessments

- Does the speaker work? If not, can they explain why?

- Presentation skills, did they document their process and present the project well?
- Documentation: Does it reflect the project in the best possible way? How could it be improved?

Knowledge
Science: current, energy, electricity, sound, how things work in real life

Skills

Standards
- Vibrations and sound waves PS 4.4c

Resources http://education.jlab.org/qa/electromagnet.html

Process
1. Form groups and examine the materials needed for the project. Make sure to document the following steps through the use of photography, videography, and especially note taking. You will use this documentation in your individual blog posts.
2. Read through and follow the steps here of the attached pdf from MAKE magazine to make your own speaker.
3. Experiment by making at least two different versions with something different than the specified materials (be sure to note the difference you're experimenting with, for example: a smaller plate, a paper plate, bigger coil of wire, etc).
4. For homework: Write a blog post detailing your project. Discuss the process you went through, any experimentation you did, and the results you saw. Be sure to post pictures and videos. If anything didn't work the way you thought it would, be sure to note this and why.
    a. For example, if you experimented with a smaller plate and it didn't work, try to discuss why you think it didn't work.

PROJECT 3: Squishy Circuits
Grade 7, Unit 2

Materials

Part I

For the class:

- 5lb bag of flour
- 1lb box of sugar
- 1 bottle of vegetable oil
- 2 1.5oz jars of Cream of Tartar
- 1 canister of table salt
- 1 gallon distilled water
- food coloring (set of four)

Per group:

- medium-sized pan
- stove top burner
- plastic spoon to stir with
- measuring devices (graduated cylinders, beakers, etc)
- small plastic bags (for storage)

Part II

(Assuming approx 20 students)

- 40 LEDs (These are extremely cheap LEDs that you can only purchase in bulk):
  - Red LEDs
  - Blue LEDs
  - Green LEDs
  - Yellow LEDs
- 10 multimeters (one per group or groups can share)
- 10 9 Volt batteries and holder
- Conductive and Resistive play dough from the previous lesson

Essential Questions/Guiding Questions

- What properties make matter more or less conductive? (path of least resistance, current=voltage/resistance)
- What is the difference between a physical and chemical change?
- Why do these substances undergo a chemical change? What is the role of heat?
- What is a circuit?

- How is energy transferred through a circuit?
- Which way does electricity move?
- Why is documenting this process important?

Enduring Understandings

- Substances have characteristic properties.
- Combining individual substances can alter the properties of resultant substance.
- Some materials conduct electricity better than others.
- Electrical circuits provide a means of transferring electrical energy. (4.4d)
- Documenting a process allows the student to better understand the properties and interactions of different materials.
- Presenting the final product allows the student to reflect on their original inquiry and how it changed in the process.
- Sharing this documentation allows others to remix it for their own purposes.

Culminating Projects and Assessments

Students will make their own conductive and insulated play dough, then construct circuit sculptures out of them. After students have working circuits, they should then design a squishy sculpture based on a chosen theme. Students should be encouraged to test numerous configurations as a means of exploring the conductive and physical properties.

They should actively document the process in the form of images, video, written descriptions, etc. At the end of the projects, students will have to present their sculpture for a class critique in which they articulate the aim of their project, explain their process, and receive feedback. Final presentations will be uploaded to the class blog.

Other Assessments

- Does the circuit work? If not, can they explain why?
- Why did the student design his/her particular sculpture? Was s/he able to successfully integrate the circuit?
- Presentation skills, did they document their process and present the project well?
- Documentation: Does it reflect the project in the best possible way? How could it be improved?

Knowledge

Science: electricity, circuits, physical and chemical changes, heat

Resources
Squishy Circuits
Original squishy circuit developer. This site documents the process of creation and provides an great overview and introduction to creating circuits with the play dough, along with her TEDTalk on her research. In addition, the research team has a fantastic video portion to their website that documents everything from making the dough to constructing a circuit.

- Squishy Circuits: http://courseweb.stthomas.edu/apthomas/SquishyCircuits/index.htm
- TEDTalk: http://www.ted.com/talks/annmarie_thomas_squishy_circuits.html
- Video: http://courseweb.stthomas.edu/apthomas/SquishyCircuits/videos2.htm

Teacher/Facilitator Guide
Developed for an afterschool program to teach squishy circuits.

- http://www.pbs.org/teachers/includes/content/scigirls/activities/tech/doughcreatures.pdf

Teaching Some Concepts of Basic Electricity
An excellent introduction to electricity developed by Yale New Haven Teachers Institute (plus content for other science lessons ranging from aerodynamics to heredity here.)

- http://www.yale.edu/ynhti/curriculum/units/1989/7/89.07.01.x.html
- http://www.yale.edu/ynhti/curriculum/referencelists/elementary/EScience.html

Multimeter Tutorial from MAKE Magazine

- http://blog.makezine.com/archive/2007/01/multimeter-tutorial-make.html

PART ONE: Ch-Ch-Chemical Changes!

Lesson Overview
One way of describing the characteristics of a pure substance is by its chemical properties. Chemical properties help you describe the way one substance will chemically react with another substance. A chemical change produces a new substance with different chemical properties. Color changes, solid formation, bubble of gas formation, and color disappearance are indicators of chemical changes. In this project, salt combined with water acts as an electrolyte thus increasing the conductivity of the conductive dough. Sugar, a non-electrolyte, is the basis for the insulating or resistive dough.

Students should be familiar with the process of conducting an experiment; students should have already conducted and documented experiments exploring physical changes; students should already be familiar with basic concepts of electricity (i.e. voltage, current, conductivity, etc).
Total Time: 45 min

Learning Outcomes

- Students will make their own conductive play dough to document the effects of a chemical change.
- Students will observe, document, and analyze the properties of the substances.
- Students will develop a hypothesis to explain why the dough underwent a chemical change.

Required Materials

For the class:

- 5lb bag of flour
- 1lb box of sugar
- 1 bottle of vegetable oil
- 2 1.5oz jars of Cream of Tartar
- 1 canister of table salt
- 1 gallon distilled water
- food coloring (set of four)

Per group:

- medium-sized pan
- stove top burner
- plastic spoon to stir with
- measuring devices (graduated cylinders, beakers, etc)
- small plastic bags (for storage)

Process

1. Warmup! Have students divided into four groups as soon as they walk in. Each group should have a large sticky with one type of chemical change..Students should research and list why this is a chemical change. They should include examples as well. (5-7 min)
2. As a class, discuss indicators of chemical change and put them on the board. (5 min)
3. Have the class return back into the four groups. Two groups will make conductive dough and two will make resistive dough.
4. Test the materials. Have students review the list of materials they will be using to make their dough. Distribute small quantities of each substance and have students test them. They should record all observable properties and run a series of tests to determine what each one is. To keep students on task, give them a worksheet/checklist or only give them a set amount of time per ingredient. (10 min)
5. Based on this data, develop a hypothesis for how many chemical change indicators the dough will exhibit. (5 min)

6. Make the dough! (see attached worksheets) (20 min)

****Since students will be using graduated cylinders, etc, test their math skills and have them convert cups, teaspoons, and tablespoons to milliliters, ounces, etc.*

7. Compare. What are the new observable properties of the mixture? Document them. (10 min)
8. *Homework:* Students should upload their documentation and data to the blog. They should write a post analyzing their data and draw a conclusion about their hypothesis.

PART TWO: Squishy Design Challenge! (aka Make a Squishy Circuit!)

Overview

All materials exhibit conductive properties, but some substances are more conductive than others. Electricity moves through these substances to transfer energy, and it moves in one direction. Circuits have to be designed in a way that will facilitate this movement (e.g. does not provide too much current). With some creativity, experimentation, and research, different materials can be used to construct circuits.

Total Time: 45 min

Learning Outcomes

- Students will use the playdough to create basic circuits.
- Students will compare the properties of the conductive and resistive dough.
- Students will demonstrate their understanding of basic circuitry through the design of their circuit.
- Students will present their sculptures.

Required Materials

(Assuming approx 20 students)

- 40 LEDs (These are extremely cheap LEDs that you can only purchase in bulk):
  - Red LEDs
  - Blue LEDs
  - Green LEDs
  - Yellow LEDs
- 10 multimeters (one per group or groups can share)
- 10 9 Volt batteries and holder
- Conductive and Resistive play dough from the previous lesson

Process

1. Warmup!
2. Introduce students to basic electricity concepts *(see Lesson V on this site).* The water analogy[1]:

    - VOLTAGE: (think the height of the water in a tank) the source pressure that)pressures electrons to flow through a wire or other conductor.
    - CURRENT: (think flows like water) the flow of electrons through conductive materials such as a circuit. Students should always think of current as a *through* quantity, that is, current flows through a wire. Voltage is an *across* quantity, that is, a voltage exists)across a circuit.
    - RESISTANCE: is a measure of how it is for electric current to move through a material
    - CONDUCTOR: electricity can easily pass through; metals and electrolytes ….
    - ELECTROLYTE: a liquid or moist substance that can conduct electricity
    - INSULATOR: anything that offers a lot of resistance to electric flow
    - CIRCUIT: A circuit is a series of conductors, or things through which electricity can flow. It is a closed circuit when all of its parts are connected by conductive materials. It is an open circuit when there is either an opening in the pathway or there is a non-conductive material in the pathway such as plastic, air, or any electricity resistant material.[2]
    - SHORT CIRCUIT: A short circuit is a faulty connection created by some sort of low resistance that blocks a conducting path from one side of a component to the other. For example a wire might have come loose which connects two sides of a circuit together. Or perhaps there's some moisture on the surface of a component that creates a bypass for the current. [3]

3. Construct a squishy circuit with the class, explaining the process as you go. Introduce the conductive play dough first, then the resistive. Discuss with the students why one is a better conductor than the other by measuring the resistance (see Appendix). Since the resistance is higher with the resistive dough, not as much current can reach the LED. (15 min)
4. Place students into pairs and give each pair a slab of conductive dough and resistive dough, 4 LEDs, and a 9 volt battery. Explain that students must connect each end to one side of the circuit *(see Appendix).* (2 min)

5. Have students construct their own basic squishy circuit. Encourage them to experiment and explore the materials (i.e. adding more LEDs, changing the size of the dough they use, etc.). Have students measure the voltage, current, and resistance of their squishy circuit using a multimeter. (30 min)
6. Students should use photo or video to document the construction of their circuit and how it works. They should also record any observations of interesting behavior to report back to the class. (10 min)

Homework
Blog about the sculpture you created and upload your documentation. Focus on why you chose the design you did and any problems or successes you encountered. Do you feel you addressed the design question? Why or why not? What type of interaction did you want to create? Also focus on any interesting observations and behaviors you found while working with the materials.

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[1] Image to above taken from: http://www.spaceacts.com/apollo_13_battery_charge.htm
[2] All above definitions taken from this source: http://www.yale.edu/ynhti/curriculum/units/1989/7/89.07.01.x.html
[3] http://www.furryelephant.com/content/electricity/complete-circuits/short-circuits/

PROJECT 4: Fabric Printed Circuit Board (PCB)

Grade 7, Unit 2

Materials

Part I

- Project Kit per student (assuming 20 students):
    - 3x3” square of pure copper polyester taffeta fabric
    - 1 LED (or 2 if you want to continue working on parallel and series circuits) - use the LEDs from the previous Squishy Circuits project!
    - 220 Ohm resistors
    - two 3 Volt batteries
- Masking tape
- Alligator clips

Part II

- Copper fabric with masking tape *(from previous class)*
- Vaseline
- Salt

Part III

- Etched fabric printed circuit board and solution (from prior class)
- Project kit (from prior class)

Essential Questions

- What is a chemical change?
- What is a solution?
- How does mass production of technology impact our lives?
- What is oxidation? What happens to the copper?
- What is a circuit?
- How is a circuit designed to best accommodate its parts?
- Why is documenting this process important?

Enduring Understandings

- Matter is made up of atoms that are comprised of protons, neutrons, and electrons, and when a substance is made up of only one type of atom, it is called an element.

- Applies an understanding of the conservation of mass/energy to physical and chemical changes in a system.
- Explains that energy appears in different forms and can be transferred (moved) and be transformed (changed)
- Explains that electric circuits provide a means of transferring electrical energy

Culminating Projects and Assessments

In this project, students will conduct a controlled experiment in which they make a fabric printed circuit board. Using copper fabric, masking tape, resist (vaseline), salt, and vinegar, students create a chemical reaction that removes the copper from the fabric, leaving only traces to connect the circuit components. Through this experiment students will apply their knowledge of mixtures and compounds, chemical reactions and properties, basic circuits, and design. Students should be familiar with chemical reactions and the basics of circuitry.

Other Assessments

- Did the PCB etch correctly? If not, can they explain why?
- Did their hypothesis reflect a thoughtful prediction that drew on learned concepts and analysis of their materials?
- Were their conclusions supported by their data and evidence?
- Does the circuit work? If not, can they explain why?
- Documentation and process: Could another student replicate this experiment?

Knowledge

Science: chemical changes, circuits, Law of Conservation of Energy, electricity

Skills

- Use measurement tools safely and accurately
- How to conduct a controlled experiment
- How to translate a circuit into a PCB
- How to document their project

Standards

- PS 3.1a
- PS 3.2a,b,c,d,e
- PS 3.3a,d,e,f,g
- PS 4.2d,e

- PS 4.4d,e

Resources

The way this experiment works:

The salt and vinegar combine to form a *solution* of ascetic acid and sodium acetate. When these two substances are mixed, they can work together to corrode certain materials, like copper. In this project, we say that is acts as an *etching agent* because the solution will etch away copper we do not want.

When you submerge the copper in the solution, a *chemical reaction* occurs. If you leave the copper fabric in for long enough, the solution will erode the copper that is weaved into the fabric. Any copper that you covered in Vaseline will stay. This is called a *resist*. The Vaseline protects the copper from reacting with the solution.

We are using depth for the variable because the more copper is exposed to oxygen, a chemical reaction called oxidation occurs that speeds up the process of the copper's corrosion (for example, the copper penny experiment). Both tests will etch, but the copper fabric exposed to air will etch much faster.

Since this can be both a time-sensitive and lengthy process, the etch may not work to create a functioning printed circuit board the first time: do not despair! This is a great opportunity to discuss process and learning from it.

Printed Circuit Boards

- http://en.wikipedia.org/wiki/Printed_circuit_board

Physical and Chemical Properties

- http://www.fordhamprep.org/gcurran/sho/sho/lessons/lesson15.htm

Copper Penny Experiment

- http://www.exploratorium.edu/science_explorer/copper_caper.html

Materials

- Vinegar: http://en.wikipedia.org/wiki/Vinegar
- Ascetic acid: http://en.wikipedia.org/wiki/Acetic_acid
- Salt: http://en.wikipedia.org/wiki/Salt
- Sodium acetate: http://en.wikipedia.org/wiki/Sodium_acetate

Original Salt and Vinegar Etch Process by Hannah Perner-Wilson from MIT

- http://www.kobakant.at/DIY/?p=2575

More images from Hannah's Flickr:

- http://www.flickr.com/photos/plusea/sets/72157623861855224/
- http://www.flickr.com/photos/plusea/sets/72157623861855224/
- http://www.flickr.com/photos/plusea/sets/72157623861855224/
- http://www.flickr.com/photos/plusea/sets/72157623861855224/

PART ONE: Project Introduction and Circuit Design

Overview

Students will be introduced to the project and the concept of a printed circuit board (PCB). They will examine its historical significance and its impact on their own lives. Students will prepare their fabric printed circuit board to be etched in the following class.
Total Time: 45 min

Key Terms

1. Printed circuit board or PCB
2. Etching

Required Materials

- Project Kit per student (assuming 20 students):
  - 3x3" square of pure copper polyester taffeta fabric
  - 1 LED (or 2 if you want to continue working on parallel and series circuits) - use the LEDs from the previous Squishy Circuits project!
  - 220 Ohm resistors
- Masking tape
- Alligator clips

Process

0. Warmup! Where can you see circuits in your life? (5 min)
1. **Brief introduction to project.** Explain that students will be making their own printed circuit boards. Since this is a new approach to PCBs, the process is not very well documented, from material proportions and manipulation to duration. They are going to conduct an experiment manipulating different variables of the chemical reactions that create the etching to determine an effective process. (5 min)
2. **What Exactly are Printed Circuit Boards?** (10-15 min)

a. Introduce the concept of a printed circuit board and its impact on technology. Explain that printed circuit boards allowed companies to mass produce the electronics that we use everyday.
b. Printed circuit boards are only printed once the circuit has been tested and the designer knows that it works. You should <u>never</u> print a circuit board before testing it.
c. Circuit boards are designed for components to fit into. The individual components work together to create a system; the PCB allows electricity flows through the system to the individual components in the correct order. Trace the path of electricity through a circuit with students.
d. Explained that PCBs are usually printed with a type of milling machine. PCBs begin as thin pieces of plastic (usually green) covered in copper. Explain that the copper acts as the conductive framework to link components together and to the power source. The machine etches away the copper you do not need with a drill.

3. **PCBs in Your Project.** When you are *prototyping* (creating a quick model to see if how it works outside of your mind), it is OK to use breadboards or alligator clips. That way if you make a mistake, you don't have to start all the way at the beginning. When you have your final design, however, you want it to last forever (presumably) so you need something more steady. PCBs are better to use for your final design because it makes a stronger connection among all the components. Remember: If one component isn't connected, the entire circuit will not work. REMEMBER: it is a *system.*
4. **Design your fabric PCB (f-PCB):** (20 min)
    - Show students examples of the process.
    - Give each student an f-PCB kit containing an LED, resistor, two 3 volt batteries, copper fabric, and alligator clips. Have students create and test their circuits.
    - Next have students design their f-PCB using the masking tape to block off areas that will be etched. Students should NOT apply the Vaseline until the next class when they begin the experiment.

Homework
Research the chemical and physical properties of the three main materials they will be using: salt, vinegar, and copper. What is their chemical composition? How might they interact? Students should write a blog post about their findings.

PART TWO: The Experiment

Overview
Students will make their own fabric printed circuit board using their copper fabric. Each group will test the depth of the salt and vinegar solution to investigate the oxidizing effect of air on the f-PCB. After the students are finished setting up their experiment, the instructor will give an explanation of the chemical reaction that is taking place.
Total Time: 45 min

Key Terms
1. Chemical reaction
2. Solution
3. Oxidation

Materials
- Copper fabric with masking tape *(from previous class)*
- Vaseline
- Salt
- White vinegar
- Beaker (or any other school provided measuring resource)
- Plastic container of the same size (should be able to hold both depths of the solution)
    - Any plastic food container or top the size of the fabric piece works very well

Process
3. Review key terms and concepts. (5-7 min)
4. Students will divide into groups of two. Each group should: (20 min)
    a. Identify the independent variable (depth), dependent variable (time), and constants (ingredients).
    b. Form a hypothesis as to which one will etch best; the hypothesis should include solid reasoning behind it based on the concepts they have already learned about chemical reactions, mixtures, and compounds.
1. Have students following the Instructable procedure (included with this lesson) and rigorously document their process. If at all possible, one or both members from the team should record further observations after at least 3 hours for better data. (15-20 min)

Homework
Organize the documentation from part one of the experiment. Be sure to include lots of pictures so other students can try it themselves!

PART THREE: The Debrief and Circuit Construction

Overview

Students will observe and document the outcomes of their experiment, then compare their findings against their hypotheses. Each group will construct their circuit, then return as a class to debrief on the experiment as a whole.

Total Time: 45 min

Key Terms

Materials

- Etched fabric printed circuit board and solution (from prior class)
- Project kit (from prior class)

Process

- Students will begin by documenting the outcome of their experiment. They should address any visible changes that they see in the solution and the copper fabric. (7-10 min)
- Each group should develop a conclusion based on their observations and recorded data. Why did one level of the solution etch better than the other? What role did air play? What does the solution look like? Are there any crystal formations (sodium acetate)? (7-10 min)
- If one of there f-PCBs worked, have students construct the circuit they designed. Does the circuit work? Why or why not? (5-7 min)
- Discussion and Debrief. Each group should quickly share their results and on the interaction that happened.

Homework

Write a blog post explaining what you learned from this experiment.

PROJECT 5: Creating Paper with Embedded Lights

Grade 7, Unit 2

Materials:

- old paper to use (or cardstock, but make sure it is not coated or glossy)
- window screen cut to approximately 4 x 6 inches (or desired size of paper) for paper
- tub to put pulp/water in
- blender to create pulp
- conductive thread
- LEDs
- 3v battery(also available at ikea for $1 per pack of 10)
- conductive materials to experiment with conductive paths within paper such as:
    - 22 gauge non-insulated wire
    - string of paperclips
    - an old metal chain necklace
    - twisted tinfoil
    - *get creative!!*

Essential Questions/Guiding Questions

- What is a circuit?
- How does a circuit close, what is a switch?
- What is a conductor and what is an insulator?
- How do the properties of the matter(each material involved) change throughout the process?
- What is paper? How do we make paper?
- How does paper and the future of paper and everyday computing change when we integrate electronics?
- Why are we recycling?

Enduring Understandings

- We can use simple, everyday processes and add electronics to make new and different itereations of projects. This project shows us how by recycling and using conservation, we can create items that are new to us, but are not wasting more resources on the earth.

Unit Rationale

The students will learn about properties of matter as well as physical changes by creating paper with embedded electronics. The students will go through the process of making paper, completing a closed circuit within the paper, and testing the finished product.

- http://www.theliztaylor.com/blog/2011/05/pulp-based-computing-paper-with-embedded-leds-2/

- http://www.instructables.com/id/Pulp-Based-Computing-Paper-with-Embedded-LEDs/

Culminating Projects and Assessments
Students will follow instructions on how to make paper with an embedded LED. They will then brainstorm other materials that could be substituted for the conductive ones they used. What are other electronics they could have or would have liked to embed in the paper? Students should discuss how embedding electronics within paper could change paper use and computer use in the future. The students will then document the process and present their completed version to the class. The documentation should include: photos, videos, short written descriptions, and a finished presentation or blog post. During the presentation, they will discuss the alternatives that could have been used in the project.

Other Assessments
- Does the light within the paper work? If not, can they explain why? (They should tear apart their papers if they don't work to understand why they don't work)
- Presentation skills, did they document their process and present the project well?
- Documentation: Does it reflect the project in the best possible way? How could it be improved?

Knowledge
Science: current, energy, electricity, physical/chemical changes, recycling, future electronics, physical computing, ubiquitous computing, paper

Standards
- Properties of Matter
    - The properties of materials,
      such as: density, conductivity, magnetic materials, and solubility PS 3.1a, b, g, h; PS 4.4 f, g
- Physical and Chemical Changes
    - Characteristics of physical changes: PS 3.2a
    - Temperatures and its effect on solubility PS 3.1b; PS 4.2e

Resources
Videos:
- http://www.instructables.com/id/Pulp-Based-Computing-Paper-with-Embedded-LEDs/
- http://vimeo.com/24270404
- http://vimeo.com/24270213
- http://vimeo.com/24269112
- http://vimeo.com/4272607
- http://www.howcast.com/videos/191499-How-To-Make-Paper

Required Materials

- old paper to use (or cardstock, make sure not coated or glossy)
- window screen cut to approximately 4 x 6 inches (or desired size of paper) for paper
- tub to put pulp/water in
- blender to create pulp
- conductive materials to create conductive paths within paper (22 gauge non-insulated wire, conductive thread: http://www.sparkfun.com/products/8549, twisted tinfoil, etc)
- LEDs: http://www.ledshoppe.com/led5mm.htm
- 3v battery

Process

1. Form groups and examine the materials needed for the project. Make sure to document the following steps through the use of photography, videography, and especially note taking. You will use this documentation in your individual blog posts.
2. Collect 2 different conductive materials to make versions of the paper with (in addition to conductive thread).
3. Read through and follow the instructions on the instructable: http://www.instructables.com/id/Pulp-Based-Computing-Paper-with-Embedded-LEDs/ Make 3 different versions with your 3 different conductive materials.
4. Once you have your paper pieces completed, (and dried) test the different versions by connecting one end to the positive side of the 3v battery and one side to the negative side.
5. Try experimenting by reversing the battery. What results do you see? What would cause these results?

Homework
Write a blog post detailing your project. Discuss the process you went through, any additional experimentation you did, and the results you saw. Be sure to post pictures and videos. If anything didn't work the way you thought it would, be sure to note this and why. Be sure to detail the different conductive materials you used and the differences this caused. Did everything work? Did anything not work? Do you know why? If anything didn't work, tear apart the paper to see if you can locate the problem.

ELECTRONIC PORTFOLIOS IN THE CLASSROOM

Purpose / Goals

"Reflection is the heart and soul of a portfolio." - Dr. Helen Barrett

Often when considering methods for portfolios (both digital and traditional) we focus most on how to best represent the student's past work. While this is an integral function of the portfolio, an even greater one, as mentioned above, is the opportunity for a student's reflection on past work. Integrating writing as a form of content creation gives the portfolio a life other than merely as a virtual trophy case.

Content

The EP will serve as a cross between archive and community. It gives students the opportunity to document, discuss, and reflect on their own and other student's work. Depending on the school and student's privacy needs, the EP can also be viewed as a source to the outside world of the school and student's accomplishments.

Platform

When examining possible content management systems, platforms, and tools for Electronic Portfolio (EP) creation, one must consider the ease of project archiving, content creation (reflection and blogging), feedback and communication (comments), integration with other software (file usage, sharing), and privacy. A good platform should support all of these issues, in addition to allowing customization for the student, teachers, and school.

Two platforms that provide all of the above specifications are Digication and the Google Education suite of apps. These two platforms give students and teachers the opportunities to build EP's through building customizable sites with embedded videos, images, and blogging. Communication between teachers and students is also possible through both of the systems. One advantage to Digication, is that it's purpose is that of an EP host, whereas while the Google Education suite can be used to fill all of the necessary functions of an EP, it is not its primary focus. Both Digication and Google can be used to integrate with Google Docs, etc. One other notable difference between them is that becoming a Google School is free, whereas Digication costs money per student. Clearly, this offers a significant advantage to using Google as an EP platform.

Resources

Below are links to the platforms discussed above (Digication and Google Education Apps) as well as links to sites discussing the use of EP's within the classroom.

http://www.google.com/educators/p_apps.html
http://digication.com/

http://digication.com/assets/media/DigicationQuickstart.pdf
http://blog.kathyschrock.net/2009/06/google-apps-for-education-overview.html
http://sites.google.com/site/eportfolioapps/overview/process