Integrating Aesthetic, Engineering, and Scientific Understanding in a Hands-on Design Activity

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ABSTRACT
The Electronic Jewelry Workshop is a program in which children learn about aesthetic, engineering and scientific aspects of design through creating their own jewelry. This poster describes 1.) the hands-on, multi-dimensional approach of the workshop and 2.) implications for introducing children to technologies in a design context.

INTRODUCTION
When children learn through designing, they can gain insight into both their learning processes and real-world construction. Hands-on design activities often afford authentic problems with diverse interdisciplinary components [1]. When children experience these types of activities, their understanding of the content may be much more nuanced than if they separately painted a canvas, built a train, and connected a light bulb to a battery.

The Electronic Jewelry Workshop is a program in which children learn about aesthetic, engineering and scientific aspects of design through creating their own jewelry. In the workshop children and adolescents use a combination of basic electronics materials (such as LEDs, batteries, resistors, and switches) and basic craft materials (such as beads, feathers, and ribbon) to create jewelry with lights that glow, flash, and change color. The workshop has run in several different after-school and summer camp programs with children ages 9 to 17 for anywhere from 1 hour to several hours a week over six weeks.

Through design activities in which children build meaningful objects with technology, they learn about:

- *the nature of materials:* e.g., how light reflects against and refracts through different objects;
- *basic electronics*: e.g., practical, hands-on experience with serial and parallel circuits, short-circuiting, and concepts behind Ohm's law;
- *basic technology:* e.g., what an LED and resistor is and how a battery works;
- *personal identity:* e.g., how jewelry reveals the wearer.

Children are not only exposed to materials and ideas in an authentic way, they also learn how to manage design experiences: both how to design and how to learn on their own. First they engage in *problem-setting* by considering how to get started on a new design, how to create something that reflects their interests, which ideas to include, and which to save for later. They engage in both aesthetic and technical *problem-solving*, such as how to debug when things go wrong (aesthetically or functionally), how to adapt the design as they learn about the materials, and how to take advantage of the properties of a material. They *understand their own work processes* such as how to persevere when things don't work the way they planned, how to work through problems on their own, how to know when to get help, and how to adapt when new information is revealed.

Figure 1: Children's Electronic Jewelry

DESCRIPTION OF ONE PARTICULAR WORKSHOP
The workshop described here is a six-week summer program with 15- and 16-year-old girls at a Computer Clubhouse, (an after-school program where children up to the age of 17 can learn about computers in a social, mentored environment.) In July 2004 eight Clubhouse members, along with 5 mentors visited the investigator's laboratory. After discussing and examining the various materials and example electronic jewelry pieces, the girls were introduced to their activity for the day: 1.) making forms using Corel Draw that would serve as the base for the jewelry and 2.) cutting the forms on a laser cutter. They were told that in future workshop sessions they would add

other materials including LEDs. Workshop facilitators helped the girls to create their designs and then showed the girls how to cut them out of sheets of colored acrylic plastic using the laser cutter. At the end of the day, some girls started to incorporate the craft materials into their designs, while others just finished their laser-cut pieces.

On every Girls' Days at the Clubhouse throughout the summer, the girls worked with the plastic pieces, feathers, ribbon, pompoms, beads, LEDs, heat shrink, resistors, solder, soldering irons, and a heat gun. The soldering irons and heat gun were located on a separate table that girls used with supervision.

Figure 2: Soldering and Lasercutting

Outcomes and Future Work

The Clubhouse Coordinator said that this was the best program with our lab that she had ever participated in. The Clubhouse participants decided to donate some of their work to create a permanent display within their very limited Clubhouse space. A project coordinator integrated the workshop into her after-school science club curriculum. The investigators continue to run this and similar workshops and are developing online curriculum guides.

IMPLICATIONS FOR OTHER WORKSHOPS

The Wow factor: Many people have seen objects that blink or glow, but have no idea how they work. It bears mentioning that when children create objects themselves they learn through the process, work through frustration, and are proud of their accomplishments.

That said, it is easy for a technology to dominate an activity. Part of the "wow factor" is that the technology is foreign and often demands more attention, understanding, and fussing than other materials. For many interactions with technology, this is unavoidable, but it is both useful to be aware of this and to work towards creating technologies that play well with others.

Simple technologies have value: Though some people may consider LEDs to be an uninspiring, basic technology, many others find them beautiful and don't know how they work. Mastering a new technology and the basic science behind it can be very exciting. And it may open the door to enjoy other electronics experiences. Simple technologies should not be discounted as having little educational value. For instance, there are only a few problems that arise when making a circuit with an LED. As a result, the girls in our workshops could troubleshoot, debug, and fix the problems quickly. They not only learned fundamental concepts behind electricity, current, and voltage, they also encountered the kinds of problems that electricians and electrical engineers face when working with real objects.

Beginning the Experience: The tone of a workshop is set in its first few minutes. A fine balance exists between providing enough information to give the participants a sense of their upcoming activities and encouraging them to engage quickly and with enthusiasm. If the environment is new, it helps to let children explore the space for a few minutes on their own or engage in icebreaking activities.

Using Examples: Showing examples of previous work can be tricky. During a one-hour workshop with 10-13 year old girls, we gave each table of 8 girls a different example of a piece of electronic jewelry and no other examples. Each table copied the design of the example. In this short amount of time, we did not go into great detail about design. When we had more time to talk about design, a range of examples or older participants, this did not happen. Excellent examples made by more experienced adults or children can be inspiring to some children and intimidating to others. It may be helpful to present some combination of student work, unfinished work, and inspirational objects that could not be created with the materials at hand.

New design ideas come later: Early in our workshop girls were required to include electronics in every piece. Soon it became clear that simply exploring the craft materials can be an enriching design experience, one that sometimes resulted in new designs and interesting discussions. New and exciting design ideas often emerge from experimentation with materials. Shorter workshops may not afford the most interesting or the greatest range of designs. Still, the experience can be a good one as long as everyone's expectations are reasonable.

Dangerous Materials: Many collaborators we work with are skeptical about allowing children to use soldering irons, exacto knives, and heat guns. Safety is always the first concern, but children are empowered by responsibility. Whenever possible, children should be allowed to develop as many skills as possible. We tried to err on the side of permitting tool use, even if the use was limited.

Taking it Home: Children cannot be designers of technology without having technology in their everyday lives with which to design. Being able to take pieces home, or, even better, kits with which to make more is important. Simpler or older technologies may be easier to bring home.

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