playful invention & exploration

Rethinking Robotics: Learning through Creative Engineering

In recent years, robotics has become increasingly popular as an educational activity. At both the college and pre-college level, a growing number of schools and other educational organizations are offering opportunities for young people to build their own computer-controlled robots. In the process of designing and programming robots, students learn important engineering, math, and computer science concepts. However, a gender gap exists. Robotics tends to attract a much higher percentage of boys than girls, particularly in free-choice learning environments such as after-school programs and museum classes.

Efforts to involve more young women in robotics tend to focus on recruiting more girls and providing female role models – while continuing to emphasize building autonomous robots. Although recruitment and role models are important, our work suggests that alternative entry paths are also needed in order to engage young people with diverse interests. We need to rethink both the way robotics activities are introduced and the types of activities offered.

In this brief paper we share some successful approaches for inspiring a broader group of girls and other young people who might not otherwise have been interested in these learning opportunities.

Exhibitions instead of Competitions

Many robotics activities are structured as competitions. For example, FIRST LEGO League announces a challenge with rules each year, and thousands of teams of young people compete in local, national, and international tournaments. Competitions are motivating for many students, but alienating for others. An alternative approach is to offer young people the opportunity to display their work in an *exhibition* rather than a *competition*. For example, the Robotic Design Studio course at

Wellesley College culminates in an exhibition where family and community members of all ages are invited to informally mingle and interact with each project and its creators (while snacking on cheese and crackers), much like at the opening of an art exhibition. The open-ended nature of the exhibition format accommodates a wider range of abilities and allows room for a greater variety of creative expression – while still maintaining the motivational benefits of a public display of projects.

Personal Expression

Robotics workshops typically focus on a particular challenge, such as "Make a robot that can maneuver through an obstacle course." Instead of focusing on a single design challenge, we have found it valuable to offer multiple entry points, allowing participants to work on diverse projects based on their personal interests. For example, as part of a museum event, we offered a workshop called, "Design a Park." The park theme sparked the creation of a wide variety of robotic projects. By the end of the day the park display was teeming with activity, including chirping birds, rolling skateboarders, interactive playground rides, and an automatic sprinkler system.

Combining Art and Engineering

An engineering assignment typically consists of a problem to solve, such as dropping a box without breaking the egg inside. We have found that many young people become more engaged if they learn engineering concepts in the process of creating interdisciplinary projects that combine art and engineering – for example, designing a painting machine, building a machine that can read and play music, or making a user- programmable water fountain.

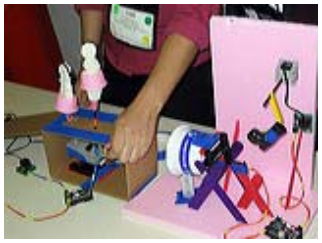
Craft Materials (Not Just Mechanical Parts)

Combining craft materials, mechanical parts, and programmable devices can inspire both girls and boys to think more creatively about what is possible and what they want to create. Instead of just providing mechanical components (such as pulleys, gears, beams, and axles), we arrange a larger palette of construction materials that include craft supplies and recycled materials (such as pipe cleaners, paper towel tubes, pompoms, and pieces of fabric). We choose the materials to match the workshop theme – for the park workshop, we provided leaves, branches, and other natural materials; for an

interactive light workshop we gathered frosted plastic cups and glittery and reflective papers. In addition, familiar objects can spark new ideas: for a workshop on future fashions youth participants brought in old belts, gloves, and boots to transform into interactive "wearables."

Narrative and Story-Telling

Some people get engaged with patterns and structures, while others become more involved in storytelling and drama. Robotics activities typically support the former style more than the latter. But a different sort of robotics activities could engage both styles. For example, a popular activity in many science centers is for young people to create a Rube Goldberg contraption, where each device triggers the next. As a variation, we have offered a chain-reaction workshop in which participants begin with a story and then design contraptions that follow a series of events with a beginning, middle, and end.



New Technologies for Artistic Invention

The design of robotics technologies can greatly influence how the technologies are perceived and used. For example, the LEGO Mindstorms robotics kits are well-designed for traditional robotics activities, such as making a robot that finds its way through a maze. We have been developing a new technology, called the Cricket, that is designed explicitly to support artistic invention. Cricket kits include multi-color lights and sound devices that can be programmed to create animal sounds, rhythms, and musical notes. The goal of this work is to expand the range of what people can design, create, and learn.

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