Art Bots (Resource Exchange)

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Dr. Besser, PE, ENV SP, holds a PhD in education and MS and BS in civil engineering. Currently, she is civil engineering chair and Center for Engineering Education director. Previous experience includes faculty positions in diverse universities where she has taught a variety of coursework including steel, timber, concrete and masonry design, construction, engineering economy, engineering graphics and engineering education. Prior to teaching, Dr. Besser, a licensed engineer, was a design engineer with HNTB-CA, where she worked on seismic retrofits and new design of high profile transportation structures.

Dr. AnnMarie Thomas, University of St. Thomas

AnnMarie Thomas is a professor in the School of Engineering and the Opus Colluege of Business at the University of St. Thomas where she is the director of the UST Center for Engineering Education. Her research group, the Playful Learning Lab, focuses on engineering and design education for learners of all ages.

Dr. Debra Monson, University of St. Thomas

Debbie Monson, Ph.D., is currently a faculty member in Teacher Education at the University of St. Thomas in Minneapolis, MN. Debbie's work in Engineering Education is a result of collaboration with the Center for Engineering Education at St. Thomas. Her interests include educating teachers and preservice teachers in ways that prepare them to teach integrated STEM topics to their students and the connections to mathematics that integrated lessons provide.

Art Bots.

Automation is something that we all encounter every single day, yet we rarely stop to think about it. In the lesson, students will use reverse engineering to take apart a toothbrush and turn it into a robot. This lesson brings awareness to the automation we encounter daily, while requiring students to incorporate what they know about circuits and robots to create their own form of automation through this creative, engaging activity.

Grade Level

Designed for 6th grade students.

Goal

Create a simple robot that is able to move and draw.

Estimated Time

60 minutes - 120 minutes

Objectives:

Students will be able to…

Discuss the different types of robots they see in their daily lives

Create a simple robot that is able to move and draw

Draw connections between this activity and the NGSS cross-cutting concepts

Standards:

MS-EST1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem

MSEST1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success

Materials/Resources:

*planning for 60 students

60 dollar-store electric toothbrushes

60 battery packs

120 AA batteries (some toothbrushes come with one; need 2/student)

75 paper cups

250 skinny markers

2 rolls black electrical tape

4 rolls scotch tape

4-6 rolls colored/patterned duct tape

10 rolls small washi tape

Pipe cleaners

Googly eyes

Sequins

Colored Popsicle sticks

Colored puff-balls

Ribbon

~6 small bundles of yarn

2 bottles of Elmer's glue or tacky glue (for optional eyes and puffballs)

12 pairs of scissors

Paper to test bots (we love using white roll paper)

*Amounts of each material can be adjusted depending on the number of students

Notes:

Make sure to encourage creativity! No two art bots should look the same. Encourage them to add googly eyes, pipe cleaners, paper, markers, etc.

Failure is an important step in the Engineering Design Process! Teachers should encourage students to test their Art Bots along the way and making adjustments as needed.

Miscellaneous:

Students finish at very different paces with this activity. Be prepared to address all different skill and interest levels. When a student feels finished, find additional ways to ask how they may be able to improve their bot. If a student seems frustrated, ask how you can help with simple things like holding tape or offering an extra set of hands**.**

Contingency Plan:

If students finished early they will be encouraged to ensure that it is functional, and then move into a time of decorating. After this, they may assist others, continue to test, or find other ways to decorate their bots.

Lesson Plan.

Prep:

- Set up all materials
- Have 1 toothbrush, 1 cup, 1 battery pack, and 2 batteries ready for each student

Learning Plan:

Part 1: Discussion

- Start a discussion about different robots that are used every day. This could range from TV remotes to refrigerators to computers. Talk about how these robots continue to improve lives around the world and change the ways that people live.
- Ask students what they think is the best thing that robots have done. Why do they think that? Why do they want to learn more about them?
- Encourage them to "find their why" and determine why they want to learn more about this topic. This is an important step in getting students to find a way to connect to the project.

Part 2: Toothbrush Take-Apart (15 minutes)

- Relate the previous discussion about robots to a toothbrush. Show the students a toothbrush and analyze the different parts.
- Next, talk with students about the value of taking things apart and putting them back together. What do we learn through this process? Why is that knowledge valuable? Remember to "find your why." Why do you want to know more about this topic?
- Remember the Ghanaian proverb- "If you educate a woman, you educate a nation." In the U.S., women still take on the majority of childcare and make up the majority of teachers/educators. When women and girls gain knowledge, it doesn't end with them but is spread to many others.
- Share with students all of the components they should find in their toothbrush (spring, battery, and motor).
- Hand out toothbrushes to each student ad allow them to begin taking apart and putting back together their toothbrush, exploring how it works.
- Have the girls disassemble the toothbrush to get the motor out:

  -Take the toothbrush out of the packet

  -Save the battery to use in the battery pack

  -Take off bottom colored part of toothbrush to expose the inside of the toothbrush

  -Use scissors/pliers to pull out plastic battery holder

  -Once the motor is exposed, try to pull the motor out by the spring (we don't need the spring, so it's fine if it's damaged)

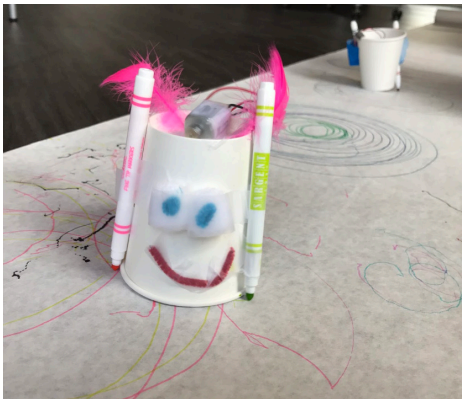
  -If needed, snap off the head of the toothbrush, it can be easier to hold to get the motor out and possibly push through the hole it creates in the top

Part 3: Art Bot Creation (45+ minutes suggested)

- Offer students their challenge: to create a robot that draws on its own. Share with students the materials they will be provided (if not already on the table, put them out). Give students the tip of how to unscrew the screw on their battery pack with the small metal piece in their toothbrush.
- Once the motor has been removed from the toothbrush, explain to the girls how they must attach it to their cup and have them explore and discuss how they will get the cup to move.
- Attach the battery pack to the two pegs of the motor (make sure the girls test this to ensure that it is connected properly).
- Allow students to continually work by prototyping, testing, and improving.
- Talk with students about the importance of "failing forward" in all areas of life. Engineering can help us learn this life skill and can also help us to better empathize with other people in our lives after they fail. "Failure is not the opposite of success; it's part of success" -Arianna Huffington, founder of the Huffington Post
- Make sure to encourage originality and both functionality and aesthetic appeal of their creation.
- The students should each attach up to three markers to their bot (have them take the marker caps off at least once before attaching them, as new marker caps can be hard to take off).
- Decorate! Use any of the materials laying out, make sure to have glue and fun tape to decorate the cups.
- Teachers-make sure there are large pieces of paper set out to test the art bots when they are finished.
- Give students a five-minute warning before a final test of all bots
- Test and showcase all art bots on the same space.

Part 4: Debrief (10 minutes)

- Have students turn off their art-bots and transition into a debrief. This conversation should either be about successes and challenges of their process, how this activity connects to an engineering design process, OR cross-cutting concepts seen in this challenge (depending on the focus) OR talk about the value of failure. What did students learn about the value of failing? What positive impacts can failure have?



Teachers:

Prompt students with questions as they engage in the inquiry activity of a robot

Introduce the NGSS cross-cutting concepts and facilitate the conversation of how this relates to the project

Engineers:

Address how circuits and systems play an important role in college engineering classes/ real-world projects

Assist students in connecting their circuits (putting tape on the wires and connecting them to the motor is always frustrating for a couple of students)

Researchers:

What connections do students make with their prior knowledge of circuits?

Communication and collaboration: what are students saying when they are working together? Are students seeing what others are doing and using their ideas? When they reach a problem point, who/what do they look to for guidance?

Cross-Cutting Concepts

- How does this enhance learning?
- Are stents using these terms or ideas in conversations? In what way?

Other Resources:

Literature Tie-In, Automation and Circuit Instruction, Art Bot supplies observation, Art Bot creation, Art Bot testing

https://bit.ly/37AY4pm (Prezi)

https://bit.ly/36uUFa5 (Automation Explained)

https://bit.ly/38XdWmv (Nest 1)

https://bit.ly/315XQ75 (Nest 2)

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