cubelets
ROBOT BLOCKS

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Challenge: Line Follower

Lesson Overview

Students attempt to design a line-following robot construction.

Students apply their knowledge of data flow diagrams to design, construct, test, and revise robot constructions that can trace lines of black tape around a table. Please note: use black painters tape or electrical tape - coloring with markers on the paper won't be a strong enough contrast for our Cubelets sensors!

Lesson Tags

Grade Level
4+

Difficulty
Master

Duration
45 minutes

Prerequisite Knowledge
SENSE, THINK, and ACT
Modeling Cubelets
Data Flow Diagrams

Supplies

Cubelets
Each group needs a 2 Distance Cubelets, 2 Drive Cubelets, a Blocker, and an assortment of other Cubelets.

Other Supplies
White butcher paper
Black painters tape or electrical tape

Description

Outline

- Teacher presents challenge
- Students work in groups to collaboratively design their robot construction using Data Flow Diagrams
- Students prototype and test their design
- Students revise their design until they are successful

Objectives

Students will use Design Thinking to design and prototype line-following robot constructions.

Assessment

Teachers look for:

- Students iterating through the steps of Design Thinking
- Students using collaborative language
- Students planning and revising their designs using data flow diagrams

How did this lesson work for you? Let us know! https://tinyurl.com/MR-GB-fdbk
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Standards

ISTE

4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
4.c. Develop, test, and refine prototypes as part of a cyclical design process.
4.d. Students demonstrate an ability to persevere and handle greater ambiguity as they work to solve open-ended problems.
5.c. Students break problems into component parts, identify key pieces and use that information to problem solve.

K12CS

Algorithms

Grades 3-5 Different algorithms can achieve the same result. Some algorithms are more appropriate for a specific context than others.
Grades 6-8 People design algorithms that are generalizable to many situations. Algorithms that are readable are easier to follow, test, and debug.

Variables

Grades 3-5 Programming languages provide variables, which are used to store and modify data. The data type determines the values and operations that can be performed on that data.

Modularity

Grades 3-5 Programs can be broken down into smaller parts to facilitate their design, implementation, and review. Programs can also be created by incorporating smaller portions of programs that have already been created.
Grades 6-8 Programs use procedures to organize code, hide implementation details, and make code easier to reuse. Procedures can be repurposed in new programs. Defining parameters for procedures can generalize behavior and increase reusability.
Grades 9-12 Complex programs are designed as systems of interacting modules, each with a specific role, coordinating for a common overall purpose. These modules can be procedures within a program; combinations of data and procedures; or independent, but interrelated programs. Modules allow for better management of complex tasks.

Vocabulary

Block Value
Variable
Average
Data Flow Diagram

Resources

Attachments

Designing with Data Flows Worksheet

Tips & Tricks

Use black painters tape or electrical tape for your lines - coloring with markers won't be enough contrast for our robot sensors.
Try making some right angles and some curves to see the robots in action!

Pacing

5 minutes - Introduction
20 minutes - Students Design with Data Flow Diagrams
10 minutes - Students prototype, test, revise
10 minutes - Share out and Exit Ticket

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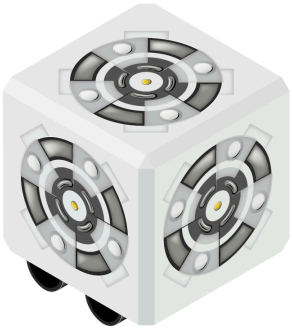
Instructional Steps

Step 1 - Pre-class setup

Time: 10 minutes

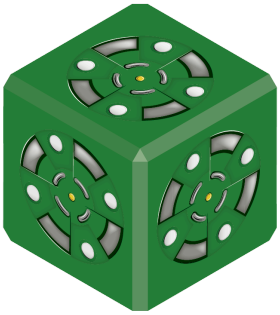
Cubelets You Will Need:

(per group or station)



Drive ACT **x2**

Distance SENSE **x2**



Blocker THINK

Assorted ACT Cubelets

Assorted THINK Cubelets

Assorted SENSE Cubelets

Sample Line-Following Robot

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Step 2 - Cultivate Wonder

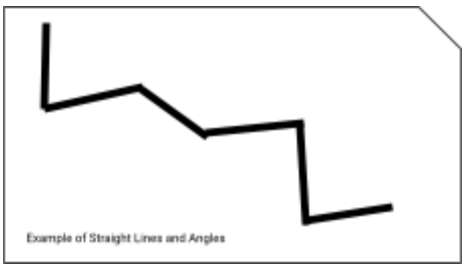
Time: 5 minutes

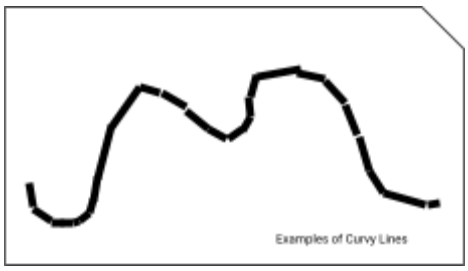
Review Data Flow Diagrams

We've been creating data flow diagrams to model our robots. Today, we're going to try *designing* a robot with our data flow diagrams to see how modeling can be a useful tool in solving problems, not just a new way to record solutions. What are some important things we need to remember as we design today?

- [Label each Cubelet in the diagram]
- [SENSE Cubelets don't pass information *through* - only *from* their SENSE face]
- [All other Blocks pass along the **weighted average** of the inputs they received]
- [Arrows are important]

Today, we're going to be designing a Line-Following Robot. This is a robot that traces a black line on a piece of paper. Here are some example tracks your Line-Follower Robot will need to follow to be successful!





Some of you may have built one of these previously, but remember, the trick is that your group must design your builds with data flow diagrams *before* you can prototype with Cubelets. Just like we did with our Edge-Sensing robots, your group will be responsible for designing three possible solutions you'd like to try using data flow diagrams.

Step 3 - Experience Before Expertise

Time: 10 minutes

Design using Data Flow Diagrams

We will use the next ten minutes to design our data flow diagrams.

First, I'd like your group to spend five minutes brainstorming what important things you'll need to consider.

What SENSE Cubelet(s) might you need?
What orientations of blocks might be important?
What are problems you anticipate needing to solve?
How might you solve some of those problems using your design?

Make notes about your conversation on page one of your design notebook in sections one and two.

Now, please spend five minutes silently planning your own ideas. You may (and should!) include design elements you discussed with your group and took notes about in sections one and two. At the end of five minutes, please have four different ideas recorded about how you might like to build your robot construction.

Notes

Intentionally including individual think time is important for students of all ages and abilities. Depending on students' familiarity and comfort with Cubelets, you might consider giving students individual think time before initially brainstorming with their group, or you might follow the order listed here that sandwiches think time between two collaborative thinking opportunities.

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Step 4 - Co-Construct Meaning

Time: 20 minutes

Collaborate to Design and Prototype

For the next ten minutes, discuss your ideas with your group. As a group, you will need to agree on the **first** three builds you will try when we prototype. Feel free to design new ideas as a group - you don't have to just *choose* from the ideas during your independent think time (although that is fine, too, if you can all agree!).

Remember, if you have time left over after your group has prototyped and tested all three of your agreed-upon ideas, your group may choose other builds that weren't included in the first three.

Once your group has agreed on your three first builds and you each have recorded physical models or data flow diagrams in your design notebook, your group may come check out Cubelets to build and test your prototypes. Be sure to make notes on your designs about what worked and what didn't work! You'll need your notes as part of your reflection today.

Notes

It might be helpful to have students use a scaffolded discourse structure during their ten-minute consensus building. One modified protocol to support this discussion could be::

- Generate-Sort-Connect-Elaborate from Making Thinking Visible
  - Students cut out their four ideas, then groups sort the ideas into like piles.
  - Group then draws lines connecting the different piles (or individual designs) labeling similarities.
  - Group then elaborates on connections to co-design or modify existing designs.

Step 5 - Check for Understanding

Time: 10 minutes

Reflection and Exit Ticket

Individually or in groups, students fill out the last page of the design notebook - reflecting on successes and failures during the prototyping stage and making plans to further revise or improve their prototype for future tests.

Depending on your classroom structure, you might also include time for groups to share their most (or least) successful builds with the class.

Differentiation - Intervention & Extension

Time: NA

Intervention

Some things to consider during the design phase could include:

- This challenge is very similar to a Steering Robot. Try building one with your students. *See example at right.*
- What direction should the SENSE Cubelets face?
- Instead of tracing, what if we think about SENSE Cubelets that can't cross the black line?

Extension

- Have students draw and label **two** data flow diagrams: one of the robot with neither SENSE on the black line and one of the robot with one SENSE on the black line.
- Students can write or draw build instructions or advertisements to try to "sell" their line-following robots.
- Students could design the black line to represent the plot line of a book or article.
- Students could explain the benefits of, and possible applications of, line-following robots.