Adapted to STEMAZing ECE Format by
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Checkerboard Coding

NOTE: Children should always be given ample time to experiment, notice, and wonder before they are provided an explanation.

Always engage children with our two favorite questions:

What do you notice? What do you wonder?

Resist the urge to answer any questions children have while exploring. Instead, respond back with questions to children and let them make sense of the world. Sample questions you might use: What do you think? Do you notice any patterns? What could we change? Can we test something else? What can we try next? If children ask a testable question, which they could answer by doing an experiment, talk through with them how they might design a test to help answer their question. As much as possible and within reason, let them actually test their questions by trying the experiments they propose.

Key Question

Can you use simple commands to program the ping-pong ball robot to reach its target animal?

Learning Objectives

Young computer programmers will…

- learn how to program their ping-pong ball robot to move from its starting position to one of the target animals.
- use the terms forward, left, and right to describe how the robot needs to move to reach the target animal.

Vocabulary (See **What the heck? Explanation of Science** at the end for definitions.)

Animal	Forward	Programmer
Code	Function	Right
Coding	Left	Robot
Command	Loop	Sequence
Debugging	Program	

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Materials

$1 Checkboard Game

2-4 Ping-Pong Balls

$1 Plastic Animals

Googly Eyes (optional but highly recommended)

Glue Dots or tape

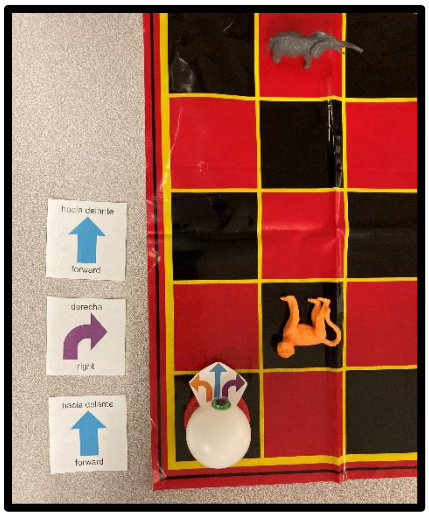
Copies of Command Cards and Robot Base (Arrows and Function)

SAFETY CONCERNS

- Some parts are small and could be swallowed.

Notice and Wonder Developmentally Appropriate Practice

1) Have children make ping-pong ball robots by taping the direction arrows to one of the checkerboard game pieces. Then stick the ping-pong ball into place on top of the game piece. Each robot can be customized by giving them multiple eyes, drawing faces on them, adding hair, etc. One example is shown to the right.
2) Place one or more ping-pong ball robots in the corners of the checkboard to start off.
3) Place plastic animals randomly around the game board, as shown on the first page.
4) Code to animals! Using the command cards, children should create a series of commands, which will direct the robot to one of the target animals.
5) Once they have the sequence of commands finished, they should have another student test their program to see if it works. (Can you see how the program shown in the image to the right will direct the robot to the square with the monkey?)
6) If there is a bug, and the robot does not make it to the target animal, then the programmer should debug their code and test it again.



Children should notice…

- programs can be written to successfully move the robot to where you want it to go using the command cards.
- some of the programs are longer than others.
- there is more than one way to program the robot to make it to the same animal.

Extensions for Additional Learning

As always, ask the children throughout the experiment what they notice and what they wonder. If their wonder questions are testable, as much as possible and within reason, let them actually test their questions by trying new experiments.

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See below for examples of what they might wonder and experiments they might do to test their wonderings.

- I wonder if I can program the robot to go to more than one animal in a single program?
- I wonder if there is a way to shorten the code in a program?
  - Let them try it!
- I wonder how real robots work?

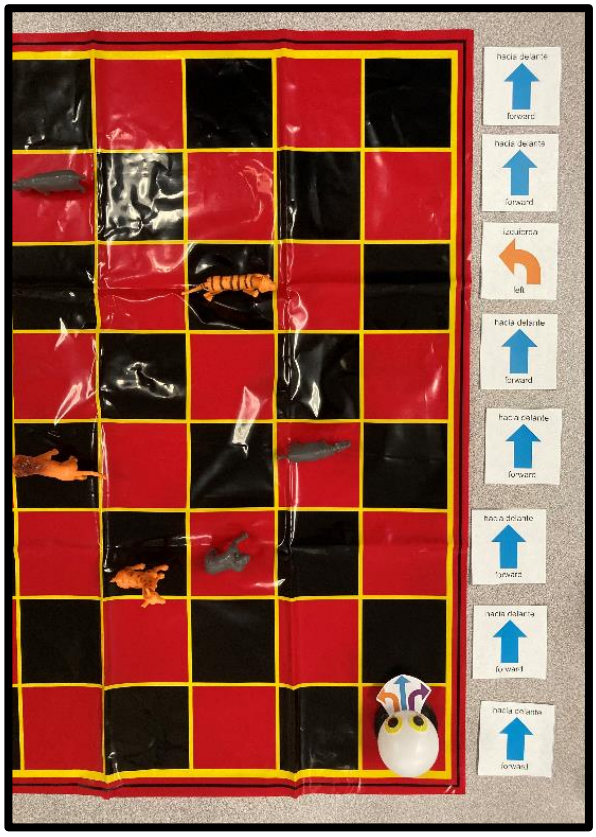
Differentiating Developmentally Appropriate Practice

For younger children, you can keep the animals closer to the robot at first so the programs do not require too many steps.

For older children, you can introduce the idea of loops and functions using the command cards with circular arrows with numbers in them and the command cards with the function symbol.

Using Loops to Shorten Code

A longer code, like the one shown to the left directing the robot to the tiger, can be shortened significantly using looping forward commands as shown in the image below. The five forward command arrows were replaced with a single command card that has a forward arrow with a five-count loop – this means that command will be repeated 5 times. The two forward command arrows were replaced with a single command card with a two-count loop – this means that command will be repeated 2 times. The short code on the right accomplishes the same end result as all the single command cards on the left. Look at how much shorter the program is using loops when you have to repeat the same command.



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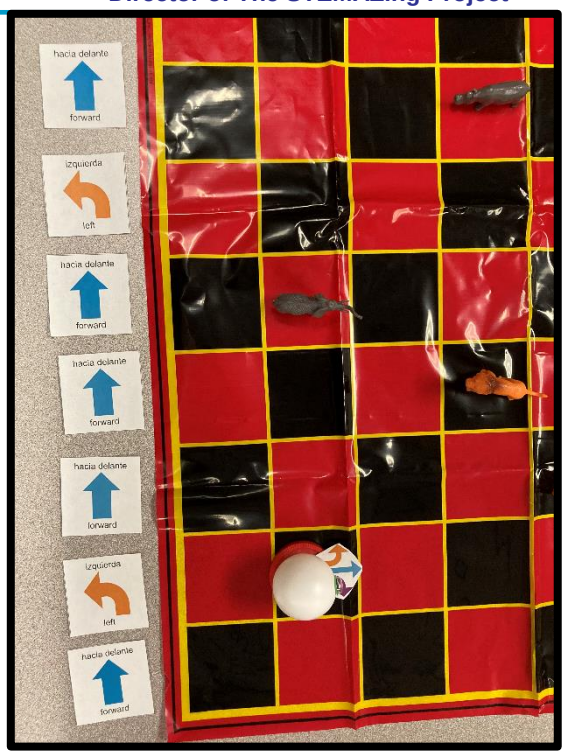
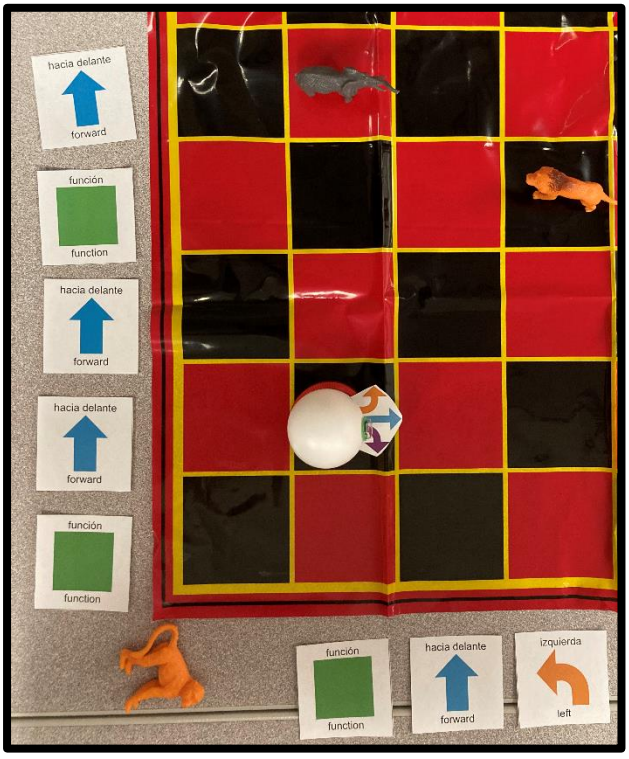
Using Functions to Shorten Code

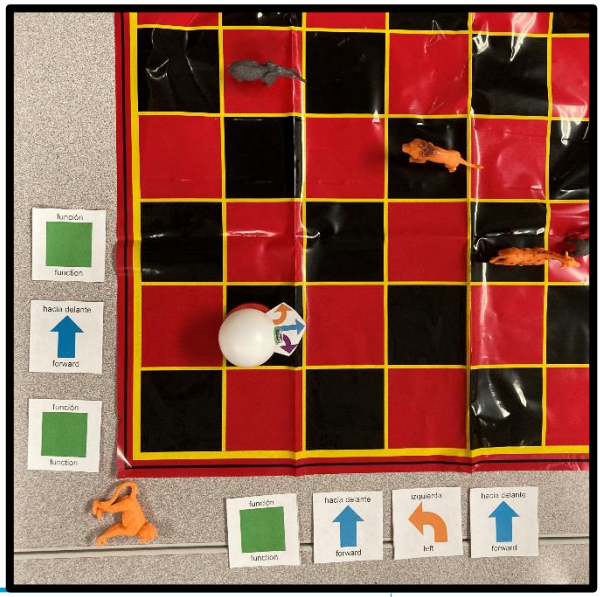
If you are coding a program, and you begin to notice that you have to keep entering the same command sequence multiple times, you can turn that sequence into a function.



First, to define a function you would put a green function command card down and then put the series of commands you want the function to represent. As an example, a forward command arrow is followed by a left turn command a couple of times in the program to shown to the right which will get the robot from where it is to the elephant.



As shown to the left, you could reduce the coding needed, by defining the green square command to be a forward command followed by a left turn command. Now, each time you want to use that sequence, you simply place a green function command card into your program. This program will also get the robot from its new starting position to the elephant.



But, if we look at the long program in the top right picture again, we could actually define the function sequence to be forward, left turn, forward. In that case, then the program to the right will also get the robot from its new starting position to the elephant using the function command cards.

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#STEMAZingPictureBook Recommendation:

Baby Loves Coding! by Ruth Spiro

Connections to lesson:

Demonstrates a series of commands or steps to accomplish a task.

AZ Early Learning Standards

Science Standard - Strand 1: Inquiry & Application - Concept 1: Exploration, Observation & Hypotheses
The child observes, explore, and interacts with materials, others, and the environment.

Science Standard - Strand 1: Inquiry & Application - Concept 2: Investigation
The child researches their own predictions and the ideas of others through active exploration and experimentation.

Checkerboard Coding

What the heck? Explanation of the Computer Programming (Vocabulary in bold.)

Computer programming is the act of giving instructions to a computer, which will then process those instructions to solve a problem or perform a task. A **programmer** is the person who is writes (or types) the code for the computer. **Code** is simply commands to be carried out by the computer. A **program** is a collection of commands (the specific steps of instructions) that will be executed by the computer. Once complete, the program will be checked for **bugs** – errors in the program that keep it from doing what it is supposed to do. If there is an issue, and the program does not run correctly, then the programmer must try debugging their program. **Debugging** is the process of finding and fixing errors in programs. Then, they check to see if their program works.

What the heck? Explanation of Checkerboard Coding

In Checkerboard Coding, children can begin to understand how we can use symbols to communicate a series of steps to a robot. This kind of activity helps develop computational thinking skills. Using the language of computer programming also helps students build their understanding of those terms. For older students, using loops is the next step in programming your robot. Loops do not have to be single command cards, but in this case, that is the extent of the loops provided. Loops allow students to look for repeating commands in their codes and try to reduce the size of their program using looped forward commands instead of just single forward movements.

Functions are another more advanced idea in computer programming. If children recognize the same repeating pattern of steps in their program, they can reduce their program size by defining the function (green square). Once they have set the green square to represent a series of command, then each time that square shows up in their program, the robot will complete all the commands that are defined by the function.

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