Activity Setup and Run-Through

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Objective:

Teach students how to use procedural thinking to solve problems. Scale the difficulty of the activity to be applicable to students of any elementary school grade level. Use materials that are readily available to an elementary school classroom. Use logical symbols to allow for the activity to be taught to young students of any demographic (language, differently-abled, lower income).

Keywords: Procedural Thinking, Education, Scalability

Materials:

- Chalk   Only used by the instructor in the setup phase
- Spacious outdoor area   To draw activity grid upon
- Sticky Notes   Roughly 25 per each student. Can be reused.
- Drawing utensil for each student   Pen/Pencil/Crayon/Marker, etc.
- Ball*   A single ball will suffice, but multiple is preferred
- Field cones*   Several cones are preferred
- 2 pieces of paper   One with a large ⬆ (arrow) and one with a ⚑ (flag)

* These materials can be substituted with other objects as long as they are still able to maintain the same functionality. Any ball substitute must be an object that can be safely picked up, moved, and placed down by students. Any field cone substitute must visibly occupy a cell of the activity grid.

Setup:

1. Instructor draws a 4x4 grid upon the ground, each cell with area large enough for a student to stand in.
2. Instructor cuts out a large arrow (↑) from the piece of paper. This will be used as a starting location.
3. (Optional) If the class size is large, several grids may be drawn in order to split up the total class into smaller learning groups.

Activity:

The activity is split into difficulty tiers that allow for the length of each learning segment to scale to the abilities of the class. This allows the activity to be performed with a wide variety of age groups. It is up to the discretion of the instructor to which tier of difficulty they believe the class should progress to.

Key	
↑ , ↓ , ←, or →	Start Location
⚑	Finish Location
O	Obstacle (Cone)

1. The instructor introduces a new activity for the students to take part in: help the robot complete the following obstacle courses.

2. Designate one student as the "robot". This student:
   ○ will not be a part of making instructions
   ○ doesn't give any instructions
   ○ can only follow pre-made instructions
   ○ cannot communicate with team members when executing instructions
   ○ can only execute instructions after they put the instructions on themselves

   The instructor tells the students that the robot can only understand its own special language of symbols, called "instructions". By giving the robot instructions, the students can help them to move towards the flag.

3. The instructor explains the following basic instruction set to the students. Each symbol can be individually written on sticky notes, which can then be stacked upon each other to signify the order of the instructions. The instructor demonstrates each instruction by guiding the current robot to complete them individually.
   a. EXAMPLE: Instructor writes "↑" on a sticky note, then passes the sticky note to the robot. The robot then takes the sticky note, displays what is written on it, and completes the instruction by moving forward one box from their starting point and starting direction. They keep the sticky note in their hand once they have finished the instruction.

| Basic Instruction Set	
↑	Move Forward Once
↻	Turn Right Once
↺	Turn Left Once

TIER 1: Moving Forward

1. Setup the grid in the following manner:
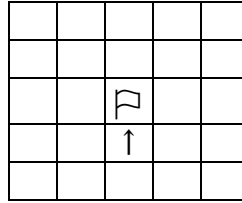
   Students are now told to write the instructions that would result in the robot reaching the destination from the starting position. Give them a bit of time to figure out potential solutions. Remember, there are many ways to complete the activity, please allow the students to be creative in their solutions.
   Potential Solution: [start] ↑ [finish]
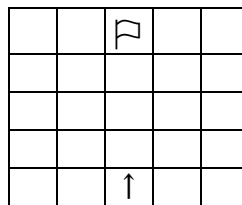
2. Setup the grid in the following manner:
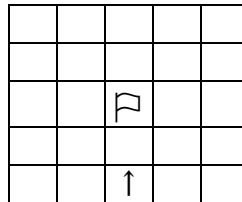
   Students are asked to write their instructions. When using multiple instructions, make sure that they stack the instructions according to the order of their execution. (First instruction should be on top of the stack, last instruction should be the last in the stack).
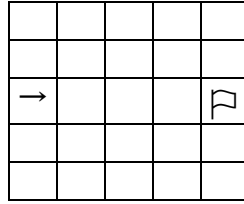   **Potential Solution**: [start] ↑ ↑ [finish]

3. Setup the grid in the following manner:

   Students are asked to write their instructions.
   Potential Solution: [start] ↑ ↑ ↑ ↑ [finish]
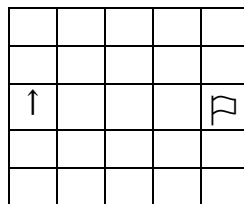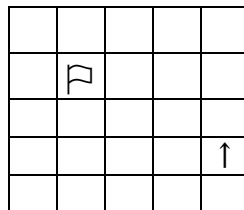
4. Setup the grid in the following manner:

→			⚑

Students are asked to write their instructions.
Potential Solution: [start] ⬆ ⬆ ⬆ ⬆ [finish]

TIER 2: Introduce Turning

1. Setup the grid in the following manner:

↑			⚑

Students are asked to write their instructions.
Potential Solution: [start] ↻ ⬆ ⬆ ⬆ ⬆ [finish]

2. Setup the grid in the following manner:

	⚑		
			↑

Students are asked to write their instructions.
Potential Solution: [start] ⬆ ⬆ ↺ ⬆ ⬆ ⬆ [finish]

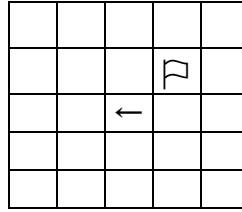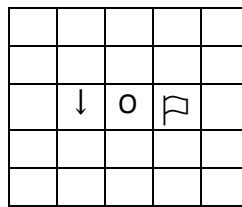3. Setup the grid in the following manner:

Students are asked to write their instructions.
Potential Solution: [start] ↻ ↑ ↻ ↑ [finish]

4. Have the students create their own courses for the robot and create their own solutions. At this point, it is recommended that a new robot is designated so that every student has a chance to try out the activity. If there are enough students present, split up into smaller groups so that the students can quickly create and solve each other's courses.

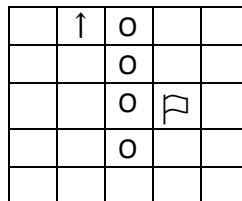## TIER 3: Introduce Obstacles

1. Setup the grid in the following manner:

Students are asked to write their instructions.
Potential Solution: [start] ↑ ↺ ↑ ↑ ↺ ↑ [finish]

2. Setup the grid in the following manner:

Students are asked to write their instructions.
Potential Solution: [start] ↻ ↻ ↑ ↑ ↑ ↑ ↺ ↑ ↑ ↺ ↑ ↑ [finish]
*This example may be a bit difficult. Instructor should give hints to the solution if asked. If the students are struggling with a solution, try breaking the exercise down into several parts and distributing the parts to groups of students.

3. Have the students create their own courses for the robot and create their own solutions. At this point, it is recommended that a new robot is designated so that every student has a chance to try out the activity. If there are enough students present, split up into smaller groups so that the students can quickly create and solve each other's courses.

TIER 4: Picking Up and Putting Down

Tier 4 involves a next level of instructions and serves as an extension to the overall activity. If the students are able to complete the previous activities with relative success, then advancing to this difficulty is recommended.

Expanded Instruction Set	
↑	Move Forward Once
↻	Turn Right Once
↺	Turn Left Once
●	Pick Up
▢	Put Down

1. Instructor states that there is a new requirement for the robot to successfully reach the flag. The flag needs to be "activated" by moving the activator (ball) to the correct place. The robot can now pick up (●) and put down (▢) the activator (Ball, B). The robot can only pick up a ball if it is in the same square as the ball. In addition, the robot can only put down the ball in the location that it is currently located. Have the instructor show the students the new symbols and how they work.

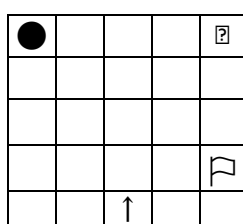| Expanded Key	
↑ , ↓ , ←, or →	Start Location
⚑	Finish Location
O	Obstacle (Cone)
●	Ball
▢	Ball Destination

2. Setup the grid in the following manner:
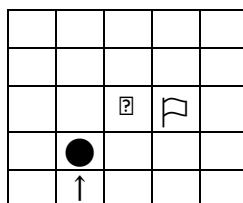
Students are asked to write their instructions.
Potential Solution: [start] ⬆ ● ⬆ ↻ ⬆ ⬚ ⬆ [finish]

3. Setup the grid in the following manner:

Students are asked to w
rite their instructions.
Potential Solution: [start] ⬆ ⬆ ⬆ ⬆ ↺ ⬆ ⬆ ● ↻↻ ⬆ ⬆ ⬆ ⬆ ⬚ ↻⬆ ⬆ ⬆ [finish]

4. Have the students create their own courses for the robot and create their own solutions. At this point, it is recommended that a new robot is designated so that every student has a chance to try out the activity. If there are enough students present, split up into smaller groups so that the students can quickly create and solve each other's courses.

Conclusions:

Students have learned how to think in a procedural way. Students are able to break down complex problems into parts and use instructions to iteratively solve them. The students are able to creatively solve problems as they see fit. By creating their own problems and solving them with their classmates, students learn to work through these problems together.

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