ASSIST CS

## Middle School
## Formative Assessment Tasks

# Algorithms

## 2-AP-10: Use flowcharts and/or pseudocode to address complex problems as algorithms.

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## Suggested Citation

Basu, S., Rutstein, D., Rachmatullah, A., Yang, H., & Tate, C. (2025). *Formative Assessment Tasks 2-AP-10: Use flowcharts and/or pseudocode to address complex problems as algorithms*. SRI International.

## Acknowledgements

We sincerely thank the teachers and students who participated in the study to test and refine this material. We also extend our gratitude to Andrea Beesley, Christopher Ortiz, Cris Jimenez, Eliese Rulifson, and Nonye Alozie as well as the Learning Partnerships team for their invaluable support and feedback on the earlier version of this material. This material is based upon work supported by the National Science Foundation under Grant No. DRL-2010591. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

# 2-AP-10 Formative Assessment Tasks

**Language from the CSTA Standard**

**2-AP-10: Use flowcharts and/or pseudocode to address complex problems as algorithms.**

*Complex problems are problems that would be difficult for students to solve computationally. Students should use pseudocode and/or flowcharts to organize and sequence an algorithm that addresses a complex problem, even though they may not actually program the solutions. For example, students might express an algorithm that produces a recommendation for purchasing sneakers based on inputs such as size, colors, brand, comfort, and cost. Testing the algorithm with a wide range of inputs and users allows students to refine their recommendation algorithm and to identify other inputs they may have initially excluded.*

***Practice(s): Developing and Using Abstractions***

***Concept: Algorithms & Programming***

***Subconcept: Algorithms***

This document is intended to support teachers' use of formative assessments in the classroom to measure middle school students' understanding of the computer science (CS) concept of "algorithms" as defined by the 2-AP-10 standard. It provides information on how formative assessment tasks can be developed to measure student understanding and challenges related to various aspects of algorithms, presents example tasks, and offers guidance on evaluating student work and identifying student challenges.

**Rubrics:** The provided rubrics for each example formative assessment task are meant to provide guidance on how to interpret student responses and identify student challenges. Rubrics are not meant to assign scores to students.

The provided rubrics follow two formats for how to categorize student responses and identify student challenges:

- **RESPONSE CATEGORY (RC)**
  - Goal: Group students into distinct categories based on response types.
  - Scoring rule: Choose only ONE response category for each student for each task/subtask.
- **INDICATOR CODE (IC)**
  - Goal: Identify the various challenges that student responses are indicative of.
  - Scoring rule: Choose ALL indicator codes that apply for a student on a given task/subtask.
  - If no indicator code applies for a student, this implies that the student is able to successfully engage with the learning target without demonstrating any challenge.

**Table of Contents (nine example tasks provided below):**

## LT1

| | | | |
|---|---|---|---|
| **Learning Target** | **Knowledge that an algorithm is a step-by-step, ordered set of instructions for solving a problem, and in order to be computer-understandable, the instructions must be precise and unambiguous.** | | |
| **Item Idea** | Give students examples of instructions, diagrams, etc. showing how to solve problems and have students determine whether they are representative of algorithms. *Could be used as a discussion prompt for the class. | | |
| **Task Features** | • A problem or scenario that needs to be solved and/or programmed<br>• One or more ways of representing the same scenario | | |
| **Variable Features** | *Feature* | *Variation 1*<br>**2AP10.LT1.1** | *Variation 2*<br>**2AP10.LT1.2** |
| | Purpose of the algorithm | • Steps to make hot chocolate | • Steps to make hot chocolate |
| | Number of ways the algorithm is represented | • Four | • Three |
| | How the algorithm is represented (flowchart, list, diagram, etc.) | • Diagram, directed graph, and lists | • Lists and diagram |
| | Format of the tasks: MCQ or open-ended | • Multi-select question followed by open-ended response | • MCQ (multiple choice question) with single response |
| | Complexity and type of the scenario | • Simple text description, no programming concepts needed | • Simple text description, no programming concepts needed |

**Note on LT1 tasks:**

The two tasks presented here are alternative versions of each other, meaning that only one version should be administered to students. The main difference between these two tasks is that one includes an open-ended explanation prompt that requires students to articulate their reasoning, while one is merely a multiple choice question.

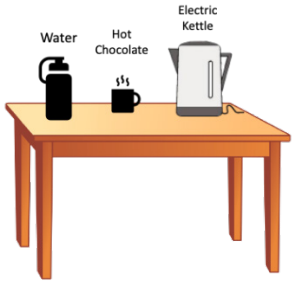
**Task 2AP10.LT1.1**

i. Which of the following is an algorithm a person could use to make hot chocolate? There may be more than one correct answer. **Select all that apply**.

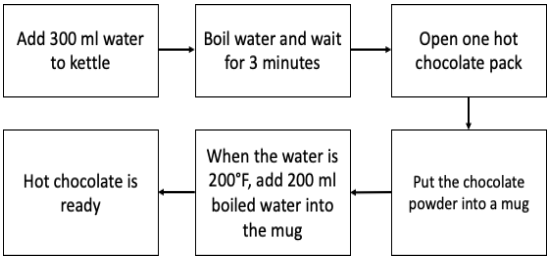
A.

Step 1. Buy hot chocolate packet.
Step 2. Get a clean mug.
Step 3. Turn on the music.
Step 4. Drink hot chocolate.
Step 5. Boil water in a kettle.

C.




B.




D.

Step 1. First, bring water to a boil in a kettle.
Step 2. Open one hot chocolate pack.
Step 3. Put the hot chocolate powder into a mug.
Step 4. When the water is between 195°F and 205°F, add it into the mug.
Step 5. Stir it and serve.

ii. Why do you think your answer or answers are algorithms for making hot chocolate?

_____

_____

**Rubric 2AP10.LT1.1**

(i)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A only | Challenges with order and final goal: Student does not realize that the steps of an algorithm need to be in order/sequential and the last step should be the goal, which is making hot chocolate. | RC1 |
| C only | Challenge with representation: Student does not realize that an algorithm is a process or ordered set of steps to get to a goal state; a static diagram depicting objects is not an algorithm. | RC2 |
| **B and D** | **Student understands what defines an algorithm and can recognize an algorithm in various forms.** | **RC3** |
| B only OR D only | Student understands what defines an algorithm but can only recognize an algorithm in certain forms (i.e., flowchart/diagram process or procedure list). | RC4 |
| Any other combination of responses | Student may not understand what an algorithm is. | RC5 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| Student response: | Possible inference about student understanding: | Indicator Code (IC) |
|---|---|---|
| Student does NOT indicate that their selected options contain instructions that are “clear” or “specific.” | Student may have difficulty recognizing that an algorithm needs to include a set of clear or specific instructions. | IC1 |
| Student does NOT indicate that their selected options contain instructions that are ordered in a logical way. | Student may have difficulty recognizing that an algorithm includes instructions that are ordered in a logical sequence. | IC2 |
| Student does NOT mention that the algorithm will fulfill the goal of making hot chocolate. | Student may have difficulty recognizing that the instructions in an algorithm need to fulfill the goal of the algorithm. | IC3 |
| Students states that the algorithm “makes sense” or that is how they would make hot chocolate. | Student may not recognize that their explanation should include characteristics of an algorithm instead of their personal opinion. | IC4 |
| Student only restates the algorithm or parts of the algorithm without explaining why it is an algorithm. | Student has difficulty understanding the concept of algorithms and/or articulating it. | IC5 |
| Student states something that is incorrect or not relevant. | Student has difficulty understanding the concept of algorithms and/or articulating it. | IC6 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

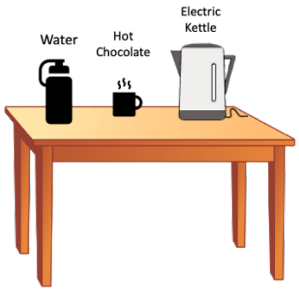
**Task 2AP10.LT1.2**

i. Which of the following is an algorithm a person could use to make hot chocolate?

A.

Step 1. Buy hot chocolate packet.
Step 2. Get a clean mug.
Step 3. Turn on the music.
Step 4. Drink hot chocolate.
Step 5. Boil water in a kettle.

B.




C.

Step 1. First, bring water to a boil in a kettle.
Step 2. Open one hot chocolate pack.
Step 3. Put the hot chocolate powder into a mug.
Step 4. When the water is between 195°F and 205°F, add it into the mug.
Step 5. Stir it and serve.

D. Options A and C above

E. All of the above options.

**Rubric 2AP10.LT1.2**

(i)

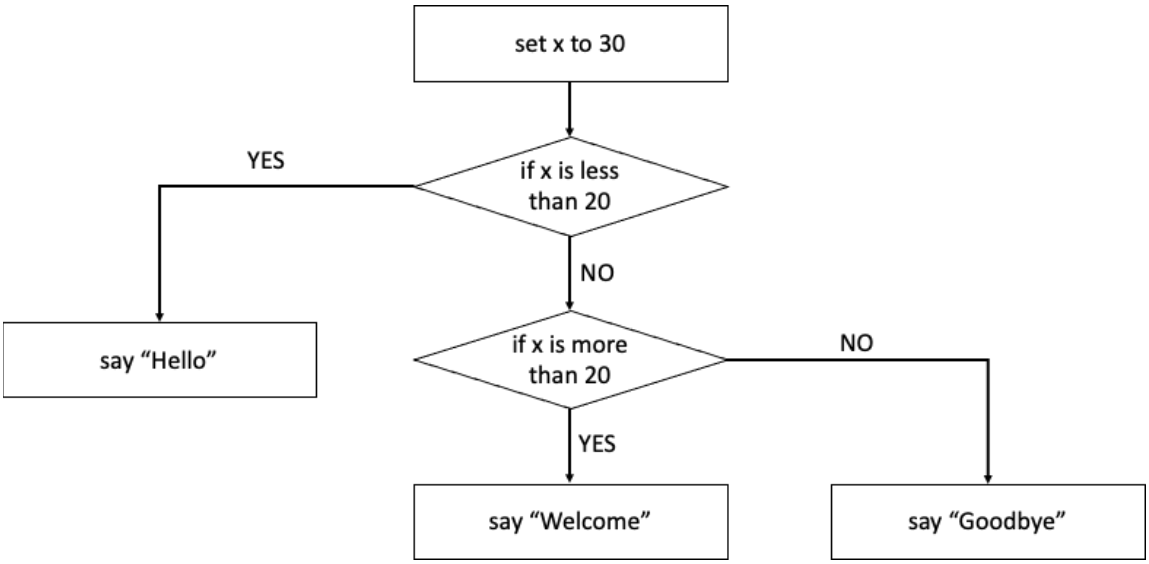
| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A | Challenges with order and final goal: Student does not realize that the steps of an algorithm need to be in order/sequential and the last step should be the goal, which is making hot chocolate. | RC1 |
| B | Challenge with representation: Student does not realize that an algorithm is a process or ordered set of steps to get to a goal state; a static diagram depicting objects is not an algorithm. | RC2 |
| **C** | **No challenge identified: Student understands what defines an algorithm.** | **RC3** |
| D | Challenge with representation: Student may think that everything that forms a list/procedure is an algorithm; hence, student does not understand what defines an algorithm. | RC4 |
| E | Challenge with understanding algorithm: Student does not understand what defines an algorithm. | RC5 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

## LT4

| | | |
|---|---|---|
| **Learning Target** | **Ability to trace an algorithm (in the form of pseudocode or a flowchart) and describe its behaviour or output when given a specific set of inputs.** | |
| **Item Idea** | Give students inputs and either a pseudocode and/or flowchart and ask them to identify or predict the output. *Can use this task multiple times with different inputs. | |
| **Task Features** | • Inputs to be used in a process<br>• The pseudocode or flowchart representing the problem<br>• Questions about the outcome of the program | |
| **Variable Features** | *Feature* | *Variation* |
| | Type of algorithm representation (flowchart or pseudocode) | • Flowchart |
| | Purpose of the algorithm | • Print different phrases based on the value of a number |
| | CS constructs covered in the assessment | • Variables, conditionals, and logical operators |
| | Format of the tasks: MCQ or open-ended | • Two multiple choice questions |
| | Complexity of algorithm | • One variable and two simple conditional statements |

**Task 2AP10.LT4.1**

Samantha traces the flowchart below to identify its output.




i. What is the output according to this flowchart?

A. Nothing will be said.
B. The program will say "Hello."
C. The program will say "Welcome."
D. The program will say "Goodbye."
E. There is not enough information to determine what will be said.

ii. If the "set x to 30" step is changed, which of the following is a value of x that would make the flowchart generate the output "Goodbye"!

A. 18
B. 20
C. 22
D. 32

**Rubric 2AP10.LT4.1**

(i)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A | Challenge with the "say" statement: Student may not understand how to read a flowchart or may not know how to interpret the "say" statements. | RC1 |
| B | Challenge with "less than" operator: Student may have trouble interpreting the "less than" operator and/or interpreting the output of a comparison statement. | RC2 |
| **C** | **No challenge identified: Student has the ability to trace a flowchart correctly and describe its output.** | **RC3** |
| D | Challenge with "more than" operator: Student may have trouble interpreting the "more than" operator and/or may not know how to interpret two conditionals in a row. | RC4 |
| E | Challenge with comparison statement: Student may not be able to interpret the comparison statements or may not recognize what x is in the algorithm. | RC5 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A or C or D | Challenge tracing a flowchart: Student may have difficulty with tracing a flowchart and/or understanding how the response options relate to the flowchart (what the flowchart will look like for each response option). | RC1 |
| **B** | **No challenge identified: Student understands how to trace a flowchart and what input will generate a desired outcome.** | **RC2** |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

## LT6

| | | |
|---|---|---|
| **Learning Target** | **Ability to select and/or create appropriate representations (e.g., pseudocode or flowcharts) to plan a problem solution that handles the desired range of inputs and is able to deal with edge cases.** | |
| **Item Idea** | Give students a set of instructions. Ask them to either create a matching flowchart or select a matching flowchart from given options. | |
| **Task Features** | • An algorithm or set of instructions | |
| **Variable Features** | *Feature* | *Variation* |
| | Purpose of the algorithm | • Create a robot to automatically find houses |
| | Selection versus creation of representations | • Selection of appropriate representations |
| | Type of representation to be selected | • Flowcharts |
| | CS constructs covered in given algorithm | • Conditional statements |
| | Complexity of algorithm | • Simple (seven lines of code including one conditional) |
| | Format of the tasks: MCQ or open-ended | • Multiple choice question with single correct response |

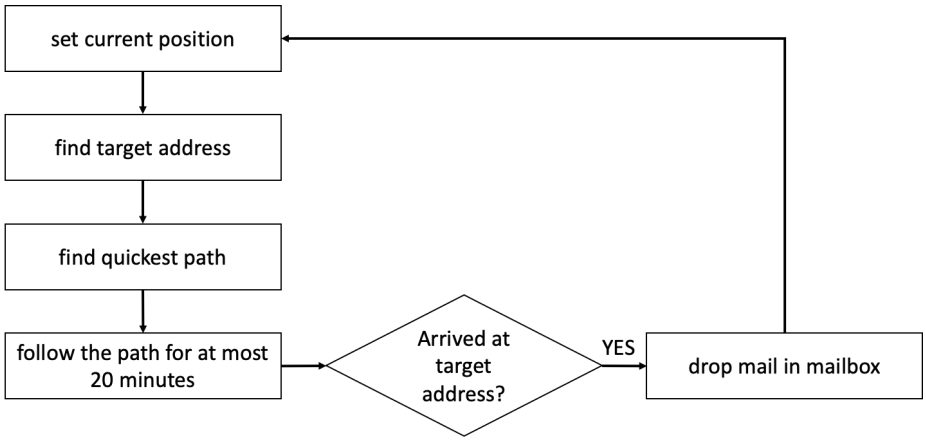
**Task 2AP10.LT6.1**

Boba is a robot that delivers mail to mailboxes. Boba should be programmed as follows to continuously deliver mail:

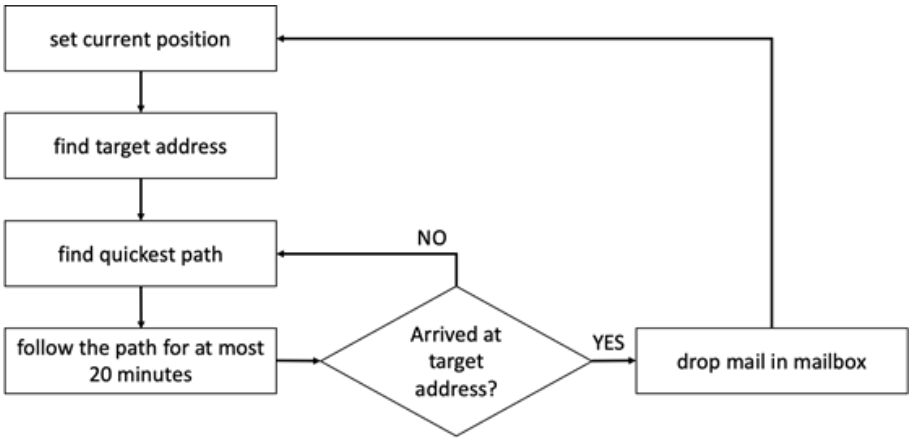
1. Set Boba's current location.
2. Find a target address.
3. Find the quickest path from where Boba is located to the target address.
4. Follow the quickest path for at most 20 minutes.
5. If Boba *has not* arrived at the target address within 20 minutes, Boba should find a new quickest path. If Boba *has* arrived at the target address, Boba should drop the mail in the mailbox.
6. Once Boba has dropped the mail in the mailbox, Boba can start the process to deliver the next mail.

Jenny is going to program Boba using the above instructions. Which flowchart matches the instructions above?

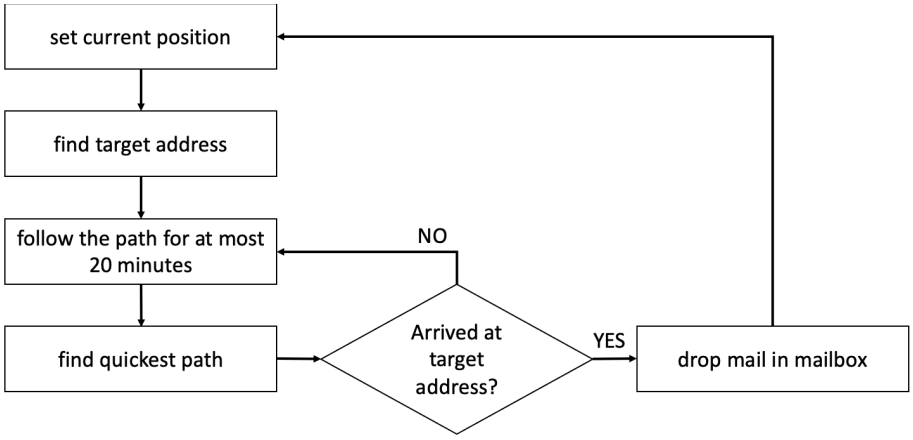
A.



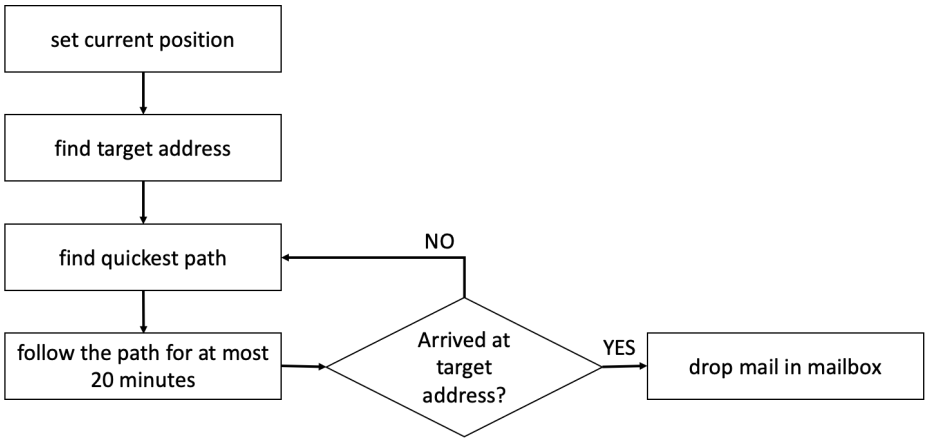

B.



C.




D.



**Rubric 2AP10.LT6.1**

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A | Challenge with decision box: Student may have challenges with interpreting Line 5 in the instructions and/or using a decision box in a flowchart. The decision box in Option A does not have an arrow labeled "NO" flowing out of it. | RC1 |
| **B** | **No challenge identified: Student is able to select the correct flowchart representation for a problem described through a set of text-based instructions.** | **RC2** |
| C | Challenge with order of flowchart: Student does not recognize that the order of the flowchart has to match the order of the instructions. Lines 3 and 4 in the instructions are flipped in the flowchart. | RC3 |
| D | Missing step in the flowchart: Student does not realize that the flowchart does not capture Line 6 of the instructions. The process needs to start over once the mail has been delivered. | RC4 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

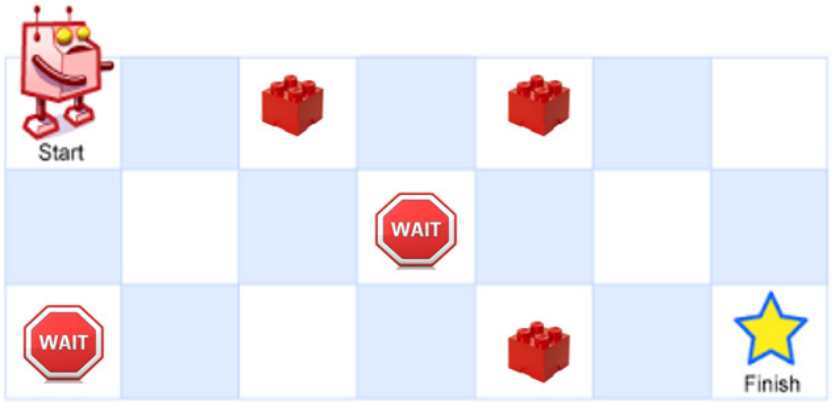
## LT8

| | | | |
|---|---|---|---|
| **Learning Target** | **Ability to compare the trade-offs between different algorithms or approaches to problem solving based on certain evaluation criteria or constraints.** | | |
| **Item Idea** | Students are given two or more algorithms for one problem, and they evaluate which algorithm(s) can produce the desired output or solve the problem based on certain criteria. | | |
| **Task Features** | • Multiple algorithms to be compared<br>• Criteria or conditions for algorithm comparison | | |
| **Variable Features** | *Feature* | *Variation 1*<br>**2AP10.LT8.1** | *Variation 2*<br>**2AP10.LT8.2** |
| | Type of algorithm (flowchart or pseudocode) | • Pseudocode | • Pseudocode |
| | Purpose of the algorithm | • To move an object through a maze | • To move ducks across a lake based on inputs |
| | Format of the tasks: MCQ or open-ended | • A set of four multiple choice questions | • A set of three multiple choice questions followed by one open-ended question |
| | Complexity of algorithm | • Simple; eight steps per algorithm; no CS constructs involved | • Complex; four steps per algorithm; multiple CS constructs involved, including compound conditional statements based on user input |

**Task 2AP10.LT8.1**

A robot has to travel from the "Start" square to the "Finish" square. During each step, the robot can move to the square directly up, down, left, or right, if such a square exists.

- Every time the robot encounters a red block on a square, the robot has to pay $5.
- Each step takes the robot 1 minute to cover. However, if the robot moves into a square that has a "Wait" sign, the robot has to wait 4 minutes before moving.




Here are three possible methods for the robot:

| Method 1 | Method 2 | Method 3 |
|---|---|---|
| 1. Move Right | 1. Move Right | 1. Move Down |
| 2. Move Right | 2. Move Right | 2. Move Right |
| 3. Move Right | 3. Move Right | 3. Move Right |
| 4. Move Right | 4. Move Down | 4. Move Right |
| 5. Move Right | 5. Move Left | 5. Move Down |
| 6. Move Right | 6. Move Down | 6. Move Right |
| 7. Move Down | 7. Move Right | 7. Move Right |
| 8. Move Down | 8. Move Right | 8. Move Right |

i. Which of the methods will get the robot to the "Finish" square?
   A. Methods 1 and 2
   B. Methods 1 and 3
   C. Methods 2 and 3
   D. All three methods get the robot to the "Finish" square

ii. Sumi wants the robot to take the fastest route that will reach the "Finish" square. Which method should Sumi choose? Remember, if the robot moves into a square with a "Wait" sign, it has to wait 4 minutes.
   A. Method 1
   B. Method 2
   C. Method 3
   D. Any of the three methods, because they all take the same time

iii. Choi wants his robot to take the route that costs the least amount of money that gets to the "Finish" square. He does not care about the time taken. Which method should Choi choose? Remember, if the robot moves into a square with a red block, it has to pay a fine of $5.

A. Method 1
B. Method 2
C. Method 3
D. Any of the three methods, because they all cost the same

iv. A competition is organized where the goal is to have the robot move from the "Start" square to the "Finish" square in 10 minutes or less by paying $5 or less. Which method can be used to satisfy the goal of the competition?

A. Method 1
B. Method 2
C. Method 3
D. None of the three methods can satisfy the goal of the competition

**Rubric 2AP10.LT8.1**

(i)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A or C or D (any option including Method 2) | Student either struggled with understanding what the individual steps mean or had trouble following the sequence of the steps. | RC1 |
| **B (Methods 1 and 3)** | **No challenge identified: Student is able to follow the steps of the algorithm correctly.** | **RC2** |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| **A (Method 1)** | **No challenge identified: Student is able to follow the algorithms and compare them based on the time criterion.** | **RC1** |
| B (Method 2) or D (any of the three methods) | Student faces challenges with matching the algorithms to the time criterion and may also not realize that they still need to pick an algorithm that works. | RC2 |
| C (Method 3) | Student faces challenges with matching the algorithms to the time criterion (student may have confused the blocks with the "Wait" signs). | RC3 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(iii)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A (Method 1) | Student faces challenges with matching the algorithms to the cost criterion (student may have confused the blocks with the "Wait" signs) | RC1 |
| B (Method 2) or D (any of the three methods) | Student faces challenges with matching the algorithms to the cost criterion and may also not realize that they still need to pick an algorithm that works. | RC2 |
| **C (Method 3)** | **No challenge identified: Student is able to follow the algorithms and compare them based on the cost criterion.** | **RC3** |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(iv)

| **If student answers:** | **Possible inference about student understanding:** | **Response Category (RC)** |
|---|---|---|
| A (Method 1) or C (Method 3) | Student struggles with comparing algorithms based on multiple criteria. Each option satisfies one of the criteria but not both. | RC1 |
| B (Method 2) | Student faces challenges with matching the algorithms to the time and cost criteria and may also not realize that they still need to pick an algorithm that works. | RC2 |
| **D (none of the three methods)** | **No challenge identified: Student is able to follow the algorithms and compare them based on the time and cost criteria.** | **RC3** |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

**Task 2AP10.LT8.2**

1. For a class assignment, Sophia and Maysie both created an algorithm that has a duck swimming laps across a lake.

| Sophia's algorithm | Maysie's algorithm |
|---|---|
| • **Step 1:** Ask for how many laps the duck should swim.<br>• **Step 2:** Check the number entered.<br>▪ **Step 2a:** If the number entered is less than 2, then have the duck say, "Not enough laps." Move to Step 4<br>▪ **Step 2b:** If the number entered is greater than 100, then have the duck say, "Too many laps." Move to Step 4.<br>▪ **Step 2c:** If the number entered is greater than 2 AND less than 100, then move to Step 3.<br>• **Step 3:** The duck swims half the number of laps entered. Move to Step 4.<br>• **Step 4:** The program ends. | • **Step 1:** Ask for how many laps the duck should swim.<br>• **Step 2:** Check the number entered.<br>▪ **Step 2a:** If the number entered is less than 2, then have the duck say, "Not enough laps." Then skip to Step 4.<br>▪ **Step 2b:** If the number entered is NOT less than 2, then move to Step 3.<br>• **Step 3:** The duck swims the number of laps entered.<br>• **Step 4:** The program ends. |

i. In Sophia's algorithm, what does the duck do if the number entered is 80?

A. Duck says, "Not enough laps."
B. Duck says, "Too many laps."
C. Duck swims 80 laps.
D. Duck swims 40 laps.

ii. In Maysie's algorithm, what does the duck do if the number entered is 80?

A. Duck says, "Not enough laps."
B. Duck says, "Too many laps."
C. Duck swims 80 laps.
D. Duck swims 40 laps.

iii. If the teacher wanted the duck to swim 75 laps around the screen, which algorithm would the teacher choose?

A. Sophia's algorithm

B. Maysie's algorithm

C. Either algorithm

Explain your answer:

**Rubric 2AP10.LT8.2**

(i)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A. Duck says, "Not enough laps." | Student struggles with following the logic of the conditional statement in Step 2a. | RC1 |
| B. Duck says, "Too many laps." | Student struggles with following the logic of the conditional statement in Step 2b. | RC2 |
| C. Duck swims 80 laps. | Student may not have recognized or understood the "half" in Step 3 in the algorithm or may have been following the wrong algorithm. | RC3 |
| **D. Duck swims 40 laps.** | **No challenge identified: Student is able to correctly follow Sophia's algorithm.** | **RC4** |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A. Duck says, "Not enough laps." | Student struggles with following the logic of the conditional statement in Step 2a. | RC1 |
| B. Duck says, "Too many laps." | Student is probably following the wrong algorithm. | RC2 |
| **C. Duck swims 80 laps.** | **No challenge identified: Student is able to correctly follow the algorithm.** | **RC3** |
| D. Duck swims 40 laps. | Student may have been following the wrong algorithm. | RC4 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(iii)

| **Student response:** | **Possible inference about student understanding:** | **Response Category (RC)** |
|---|---|---|
| **Student selects B (Maysie's algorithm)**<br>**and**<br>**Student explanation contains both Points 1 and 2:**<br>**1. Sophia's algorithm only does half the laps, up to 100, so would do at most 50 laps, or say "too many laps."**<br>**2. Maysie's algorithm would have the duck swim the number of laps entered.** | **No challenge identified: Student is able to follow the algorithms, compare them, and provide explanations for the behavior of the algorithms.** | **RC1** |
| Student selects B (Maysie's algorithm)<br>and<br>Student explanation contains only one of Points 1 and 2:<br>1. Sophia's algorithm only does half the laps, up to 100, so would do at most 50 laps, or say "too many laps."<br>2. Maysie's algorithm would have the duck swim the number of laps entered. | Challenge with generating complete explanations: Student is able to follow the algorithms and provide a partial explanation for the behavior of the algorithm. Student difficulty may be with articulating complete explanations. | RC2 |
| Student selects B (Maysie's algorithm)<br>and<br>Student explanation is missing or contains neither Point 1 or Point 2 listed above. | Challenge with generating explanations: Student is able to follow the algorithms but struggles with generating explanations. | RC3 |
| Student selects A (Sophia's algorithm) – with or without an explanation. | Challenge with comparing algorithms: Student is finding it hard to interpret and compare algorithms. | RC4 |
| Student selects C (Either algorithm) – with or without an explanation. | Challenge with interpreting algorithms: Student is finding it hard to interpret the algorithms and see their differences. | RC5 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

## LT9

| | | | |
|---|---|---|---|
| **Learning Target** | **Ability to identify meaningful test cases (including edge cases) for testing an algorithm.** | | |
| **Item Idea** | Present a problem scenario and ask students to identify the set of inputs that fully tests all possible outputs of the problem. | | |
| **Task Features** | • A program, algorithm, or problem scenario that takes in an input | | |
| **Variable Features** | *Feature* | *Variation 1*<br>**2AP10.LT9.1** | *Variation 2*<br>**2AP10.LT9.2** |
| | Scenario described in task | • Pseudocode to assess vehicle speed | • Text-based description of a calculator program |
| | Number and type of inputs | • One numeric variable input | • Two numeric variable inputs |
| | CS constructs covered in the program or scenario description | • Variables<br>• Conditionals | • Variables<br>• Mathematical operations |
| | Format of the tasks: MCQ or open-ended | • Open-ended question | • Multiple choice question |

**Task 2AP10.LT9.1**

You are testing a program that is supposed to monitor traffic based on three rules as shown below:

- Enter a value of speed.
- Rule 1: If the speed is 50 mph or faster, the program shows the message "You need to slow down."
- Rule 2: If the speed is 30 mph or faster but slower than 50 mph, the message is "You are in the safe range."
- Rule 3: If the speed is less than 30 mph, the message is "You can speed up."

i. Pick at least four values of speed that you would enter to test if the program is working correctly for all three rules described above. Explain why you would use these values of speed to test the program.

Values of speed I would enter to test if the program is working for all three rules:

Value 1:

Value 2:

Value 3:

Value 4:

Other values:

ii. Explain why you would use these values of speed to test your program.

_____
_____
_____

**Rubric 2AP10.LT9.1**

(i)

For purposes of this rubric, the different "categories" of values for speed refer to:

- Negative numbers
- 0
- 1 to 29
- 30
- 31 to 49
- 50
- Greater than 50

| **Student response:** | **Possible inferences about student understanding:** | **Response Category (RC)** |
|---|---|---|
| **Student identifies values of speed that are in four or more different categories and tests all three rules (for example, 5, 30, 45, 50).** | **Student is able to identify meaningful test cases to test all given rules or conditions.** | **RC1** |
| Student identifies values of speed that are in four or more different categories, but does not test all three rules (for example, 0, 5, 30, 40 do not test Rule 1). | Student is able to identify some meaningful test cases but may not recognize that testing an algorithm requires testing all of its rules or conditions. | RC2 |
| Student identifies values of speed that cover all three rules, but only cover three categories (for example, 5, 35, 45, 55). | Student is able to identify meaningful test cases to test the rules but may not recognize that they also need to test the boundaries of different conditions. | RC3 |
| Student identifies values of speed that are only in two or three different categories and does not cover all three rules (for example, 30, 40, 49, 50). | Student struggles to identify a full range of meaningful test cases and has challenges recognizing that they need to test the program under all possible scenarios for all three rules. | RC4 |
| Student identifies values of speed that are all in the same category (for example, 55, 60, 70, 80). | Student does not understand that they need to test the program under all possible scenarios to make sure it works for all three rules. | RC5 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| **Student response:** | **Possible inferences about student understanding:** | **Response Category (RC)** |
|---|---|---|
| **Student's explanation indicates that the speeds picked have different outputs/cover all three rules and various possible problem scenarios.** | **Student is able to provide an explanation for the selected test cases.** | **RC1** |
| Student's explanation indicates "to check that the program works." | Student struggles with explaining why they selected certain test cases. This may be because the student did not select test cases systematically and intentionally. | RC2 |
| Student states the correct output for one or more test cases they choose without explaining why they choose it (for example, "If I enter 32, it should say you are in the safe zone"). | Student may recognize how to predict the output based on input values of speed but may have challenges with explaining the purpose behind the chosen test cases. | RC3 |
| Student's response does not explain why they picked the test cases or does not relate the test cases to the output. | Student may not have selected test cases systematically and intentionally. | RC4 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

**Task 2AP10.LT9.2**

You are testing a calculator program. The program allows you to pick two numbers and add, subtract, multiply, or divide the numbers. When you ask the calculator to perform 4 + 2, it gives you the answer of 8 instead of 6.

One reason may be that the program multiplied instead of added. What operation can you ask the calculator to perform that would let you see if this is the cause of the error:

A. 2 + 2
B. 3 × 7
C. 6 + 3
D. 8 − 4

**Rubric 2AP10.LT9.2**

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| A (2 + 2) | Student recognizes they need to test addition but is not able to identify a meaningful test case (as both 2 + 2 and 2 × 2 give the same answer). | RC1 |
| B (3 × 7) | Student may think they need to test multiplication instead of recognizing that the error is with the addition action. | RC2 |
| **C (6 + 3)** | **Student recognizes they need to test addition and recognizes a meaningful test case.** | **RC3** |
| D (8 − 4) | Student may think they need to test other operations instead of recognizing they need to further test the current error. | RC4 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

## LT10

| | | |
|---|---|---|
| **Learning Target** | **Ability to test and debug algorithms using a systematic and iterative process to ensure the algorithms function appropriately.** | |
| **Item Idea** | Give students an algorithm and designated inputs. Have students trace algorithms using inputs and figure out unexpected outcomes and how to fix them. | |
| **Task Features** | • An algorithm that is partially correct or has errors<br>• An input to the algorithm | |
| **Variable Features** | *Feature* | *Variation* |
| | Type of algorithm (flowchart or pseudocode) | • Pseudocode |
| | Purpose of the algorithm | • Calculate soda wastage |
| | CS constructs covered in the assessment | • Variables, mathematical operators, conditionals |
| | Format of the tasks: MCQ or open-ended | • Open-ended question |
| | Complexity of algorithm | • Medium, includes some complexity: takes input and subtracts, needs conditionals to work correctly |
| | Problems with algorithm | • Missing conditional statement for updating variable value |

**Task 2AP10.LT10.1**

Rod works in the cafeteria and notices that the soda machine often keeps producing soda after the cup has been filled, leading to soda wastage. He writes the following algorithm to calculate the amount of soda wastage from a soda dispensing machine.

This algorithm starts with asking the user to enter the amount of soda dispensed in ounces and the cup size in ounces. The algorithm then calculates the wasted amount of soda in ounces.

Step 1. Ask user for the amount of soda dispensed and store the value in a variable called sodaProduced.

Step 2. Ask user to enter the cup size and store the value in a variable called cupSize.

Step 3. Update a variable called sodaWasted so that its value is equal to (sodaProduced − cupSize).

Step 4. Print the value of sodaWasted.

i. According to the four-step algorithm shown above, what values of sodaWasted will be printed in the following three scenarios?

| Scenario # | sodaProduced (ounces) | cupSize (ounces) | sodaWasted (ounces) = (sodaProduced − cupSize) | Real-life observed value: realSodaWasted (ounces) |
|---|---|---|---|---|
| A | 16 | 12 | | 4 |
| B | 21 | 21 | | 0 |
| C | 15 | 20 | | 0 |

ii. In the table, realSodaWasted is a variable whose value shows how much soda is really wasted for the three scenarios.

For which scenarios do Rod's real-life observed values of soda wastage (realSodaWasted) **NOT MATCH** the value of sodaWasted produced by Rod's algorithm?

A. Scenario A
B. Scenario B
C. Scenario C
D. All of the scenarios match

iii. What change or changes could Rod make to his algorithm so that the value of sodaWasted calculated by his algorithm **always** matches the real-life observed value (realSodaWasted)?

_____

_____

**Rubric 2AP10.LT10.1**

(i)

| If student answers: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| **A. 4**<br>**B. 0**<br>**C. –5** | **Student is able to follow a simple algorithm.** | **RC1** |
| A. 4<br>B. 0<br>C. 0 or 5 | Student can follow a simple algorithm but may have challenges when it comes to subtraction that results in a negative number. | RC2 |
| Only one correct out of A, B, C | Student has challenges with following a simple algorithm and/or struggles with the subtraction. | RC3 |
| All incorrect | Student has challenges with following a simple algorithm and/or struggles with the subtraction. | RC4 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(ii)

| Student response: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| **Student selects C (Scenario C), and**<br>**student selection is consistent with student responses to Part i.** | **Student is able to recognize when the program output does not match the desired output.** | **RC1** |
| Student selects C (Scenario C), but<br>student selection is NOT consistent with student responses to Part i. | Student may have challenges with comparing the desired and actual output but is still able to identify an error in the algorithm. | RC2 |
| Student selects A, B, or D (something other than Scenario C), and<br>student selection is consistent with student responses to Part i. | Student is able to recognize when the program output does not match the desired output (though the answer is wrong, student is able to do the matching/comparison task). | RC3 |
| Student selects A, B, or D (something other than Scenario C), and<br>student selection is NOT consistent with student responses to Part i. | Student may have challenges identifying the differences in the desired and actual output. | RC4 |

| Student response: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |

(iii)

| Student response: | Possible inference about student understanding: | Response Category (RC) |
|---|---|---|
| **Student indicates that the problem is when the value of cup size is greater than the value of soda produced. Solutions include checking if sodaProduced is less than cupSize and, if yes, the amount of soda wasted should be 0; otherwise, the amount of soda wasted should be (sodaProduced – cupSize).** | **Student is able to debug an algorithm and describe a fix for it.** | **RC1** |
| Student indicates that the problem is when the value of cup size is greater than the value of soda produced but does not provide a solution. | Student can identify a problem with an algorithm but has challenges when creating a solution to that problem. | RC2 |
| Student's explanation does not indicate either the problem or the solution. | Student has challenges with debugging an algorithm. | RC3 |
| No response (missing) | Student may not know how to engage with this task or may have just skipped the task. | M |