Title:
An Introduction to Algorithms: Partner Drawing through Instructions

Section I: Introduction
This lesson introduces basic computational thinking skills to fourth and fifth grade students. It is designed for school library/media center settings, and works best taught in a classroom space with open room for movement and activity. During this lesson, students will be introduced to the concept of algorithms and will engage in one collaborative drawing activity that will strengthen their ability to give specific, step-by-step instructions.

Section II: Learning Outcomes
- Students will be able to name at least one algorithm that they use in their daily lives.
- Students will be able to deconstruct a complex problem through step-by-step instructions.
- Students will be able to brainstorm how algorithms are used in computer coding in order to prepare for future computational thinking in Scratch.
- Critical Thinking Outcome: Students will be able to determine which of their directions were successful and unsuccessful in order to improve upon their instruction-giving abilities for future computational thinking.

Section III: Assessment Plan
<u>Formative Assessment</u>
- Outcome to be assessed:
    - Students will be able to deconstruct a complex problem through step-by-step instructions.

During the class session, the teacher/librarian will continually walk around the room and check in with each group's progress on their drawing activity. The teacher/librarian will be available to provide support and ask questions as needed.

During the team drawing activity, the groups will report back to the teacher/librarian periodically to check in. Each group will have a small whiteboard (or piece of scratch paper) with them. Once each of the following checkpoints is complete, the group will draw a checkmark on their whiteboard. Once the group has three checkmarks (one for each checkpoint) and approval from the teacher/librarian, they can complete a prearranged early-finisher activity or read as they wait for the next step.

Checkpoints:
1. Partner 1 has given instructions
2. Partner 2 has given instructions
3. Partners have shared their drawings and compared them to the original.

<u>Summative Assessment</u>

- Outcomes to be assessed:

- Students will be able to brainstorm how algorithms are used in computer coding in order to prepare for future computational thinking.
- Critical Thinking Outcome: Students will be able to determine which of their directions were successful or unsuccessful in order to improve upon their instruction-giving abilities for future computational thinking.

With 10 minutes left of class, the teacher/librarian will quickly recap the content of the lesson and present students with the following final reflective prompt:

- You now know what an algorithm is, you've named some algorithms you use everyday, you've created an algorithm, and you've tested it with a partner. Now we're going to brainstorm how your new knowledge of algorithms might help you better use computers.
- In a Think-Pair-Share activity, students should first write a one-sentence prediction about how algorithms are used with computer. (1-2 min). Then, with the same partner from the drawing activity, the students will share their idea. (1-2 min) The teacher will then ask for 2-3 volunteer groups to share partner predictions. (5 min)

Students will individually write their one-sentence prediction about how algorithms are used with computers.

As the students line up to exit the classroom, they will submit their individual lists of successful and unsuccessful directions. Students should also write their names on their one-sentence prediction notes and turn them in for completion. There are no correct answers to this activity; students will be evaluated based on their participation. The instructor will look over the students' lists and predictions outside of class time. The instructor will provide written feedback on the students' lists and return them during the next class meeting. Student predictions about how algorithms are used in computers can be used to introduce Scratch and coding during the next class.

Section IV: Session Outline

- <u>Before class:</u>
  - If space allows, spread out the student desks/stations for privacy during the drawing exercise.
  - Print one handout for each student.
  - Prepare whiteboards (1 for each group of 2 students).
  - Write checkpoints on board.

- <u>3 min: Welcome to class</u>
  - This is time for everyone in the class to get settled and ready to learn. The teacher/librarian can use this time to take attendance, go through any announcements, and focus the group's attention.
- <u>5 min: What's an algorithm?</u>
  - The teacher/librarian will lead a large-group discussion by prompting: "Who knows what the word algorithm means?" The students can respond with

thumbs up, thumb in the middle, or thumbs down depending on how confident they are about the term.
    - The teacher/librarian will briefly explain that algorithms are lists of directions. Algorithms are rules to be followed.
        - Examples of everyday algorithms: Giving directions to somewhere, Following or writing a recipe, Creating a study schedule, Using or creating a libguide, etc.
    - The teacher/librarian should ask the group for examples of algorithms they used that day.
    - Transition: Now that you know what algorithms are, we're going to practice your instruction giving skills. First, you need to draw a simple picture.
        - At this point, the teacher should distribute the Algorithms handout to everyone in the class. The handout reviews the content covered so far and can serve as a guide as students start the activity.
- 5 min: Draw
    - Each student will get a piece of grid paper and a pencil (grids allow for clearer instructions later on). Students will have 5 minutes to either create a simple drawing. (Examples are available on the handout if students are struggling to come up with drawings.)
    - If possible, the desks or tables should be spread apart for student privacy. Students should keep their drawings private as they're working.
- 20 min: Team drawing
    - (5 min) First, the instructor should give instructions for how the activity will go. Students will pair up into teams of two and should NOT show each other their drawings. Then, one student will describe their drawing to their partner, with the goal of having the partner recreating the drawing as accurately as possible.
        - *One important rule in the drawing activity:* The student cannot simply say, "Draw a (ex: smiley face) in the center of your paper." Students must break down their drawing into smaller components.
        - Students have the freedom to come up with their own directions. This is a pretty open activity to allow students to explore how directions can be given.
        - While the goal of this is for students to come to realizations on their own, the following hints and guidelines can be given to students to get them started:
            - Try using the grids on your paper to tell your partner *where* they should be drawing.
            - Try breaking down your shapes into smaller shapes and lines.
            - Remember to talk about scale. How big is your drawing? How much of your paper does it take up?
            - Example directions for a smiley face:
                - Start in the upper left-hand corner of your paper. Draw a large circle that takes up the entire paper and reaches each of the four corners.

        - Inside of the circle you've drawn, move your pencil about 10 grid squares to the right and about 6 grid squares down. Draw a small circle that is about the size of a penny.
        - So on and so forth...
    - The instructor should remind students to pay special attention to which of their instructions worked well and which ones caused trouble.
    - (15 min) As students complete checkpoints, they should check on a piece of paper or marker board so that the teacher/librarian can keep track of group progress. The checkpoints can also be projected or written on a whiteboard for students to reference. Once the partners have 3 checkmarks on their whiteboard and a thumbs-up from the teacher, they can read quietly or work on a prearranged library early finisher activity. (Each partner has about 7.5 minutes per turn.)
        - Checkpoints:
            - 1. Partner 1 has given instructions
            - 2. Partner 2 has given instructions
            - 3. Partners have shared their drawings and compared them to the original.
- <u>5 min: List successful and unsuccessful directions</u>
    - The teacher should prompt: "Now that you've practiced delivering instructions, take 5 minutes to assess what you did well and what you might need to work on."
    - Once the partner drawing time limit is up, students will work individually to create lists of their most successful and ineffective directions. Students should try to list at least 4 of each. Each student should develop one list.
- <u>5 min: Recap</u>
    - This time can be used for students to share their original drawings and reproductions. Students can also share what gave them trouble or what was easy.
    - The teacher/librarian might prompt: "What directions worked well? Why did they work? What gave you trouble? What made that difficult for you and your teammate?"
    - Discussion prompt: "What would you say made a *good* algorithm today?"
        - Good algorithms should be: as specific as possible, broken down into small steps, and make sense to your audience (your partner, or in some cases, your computer)
    - The teacher/librarian should offer a quick recap of class: "You now know what an algorithm is, you've named some algorithms you use everyday, you've created an algorithm, and you've tested it with a partner. Now it's time to predict how your new knowledge of algorithms might help you better use computers."
- <u>10 min: Think Pair Share</u>
    - In a Think-Pair-Share activity, students should first write a one-sentence prediction about how algorithms are used with computers. (1-2 min).

        - This one-sentence prediction will be used later as an exit slip, so remind students to hang onto them.
    - Then, with the same partner from the drawing activity, the students will share their idea. (1-2 min)
    - The teacher will then ask for 2-3 volunteer groups to share partner predictions. (5 min)
- 2 min: Exit slip submission, submit reflective lists, line up
    - As students line up, they will submit their reflective lists and prediction sentences from the think-pair-share activity as exit slips.
    - The teacher/librarian can use this time to remind students that algorithms will be used during the next class when they begin using the programming language Scratch for the first time.

Section V: Discussion

a. Information Literacy

This lesson follows the American Association of School Librarians (AASL) Standards for the 21st-Century Learner. While students are engaging in a collaborative computational thinking exercise, they are actively practicing the following information literacy skills: self-evaluation, collaboration, and information organization. AASL Standard 3.4.1 states that learners should be able to "Assess the process by which learning was achieved in order to revise strategies and learn more effectively in the future." As students reflect on their successful and unsuccessful directions, they are self-evaluating and noticing their areas of improvement for future computational thinking. Further, AASL Standard 2.1.5 states that students should "Collaborate with others to exchange ideas, develop new understandings, make decisions, and solve problems." The drawing exercise gives learners a chance to work together, deconstruct a problem, and gain new understandings and ideas from their peers. Lastly, AASL Standard 2.1.2 states that learners should "Organize knowledge so that it is useful." To gain basic computational thinking skills, students are practicing their ability to organize information and present it clearly.

b. Critical Thinking

In "The Library is the Place: Knowledge and Thinking, Thinking and Knowledge," Cabrera and Colosi argue that librarians and teachers "must infuse thinking skills into the content curriculum" (24). Rather than focusing solely on teaching *content*, educators must teach students "how to know," or skills for how to think on their own. This lesson focuses on teaching students how to deconstruct a complicated problem, try their proposed solution, and fail forward to achieve their goals. After students create their drawings and work with partners to practice delivering sets of instructions, they spend a lot of time reflecting on their thinking processes and considering how to make improvements. For instance, students "compare" their original drawings to the reproduction, "assess" their strengths and difficulties, and "predict" how their skills will be useful in the future. Each of these actions fits within the Evaluation level of Bloom's Taxonomy and show that students are continually practicing their critical thinking skills throughout this lesson.

c. Differentiated Instruction

To make this lesson suitable for all students, there are multiple adaptations that can be made. Students who are not able to express themselves through writing (students at varying levels of academic development, struggling readers, and/or English language learners) can have the option of verbally reflecting on their drawing activity. Students who do not feel comfortable writing their exit slips and/or lists of instructions can have the option of verbally contributing to the class discussion or meeting with the instructor briefly during checkout time or while the teacher is walking around to the groups during class to reflect on the exercise. Instructors could also preselect partner groups so that students with similar reading levels, language fluency, etc. can work together to achieve their goals. As an added option, paraprofessional aids could be made available for students who need help transcribing their written responses.

Section VI: Handout
See separate document: Algorithms Handout.pdf

References:

Cabrera, Derek and Laura Colosi. "The Library is the Place: Knowledge and Thinking, Thinking and Knowledge. *Teacher Librarian*, 36, 5, 2009, 24-29.

This lesson was inspired by Code.org's Graph Paper Programming lesson and CSUnplugged.org's Line Drawing lesson.