TO: AOLME Project Leaders

DATE: February 11, 2019

FROM: HRI AOLME Evaluation Team

RE: Formative evaluation feedback on Level 1 Sessions 5 and 6

As part of HRI's formative evaluation in Year Two, we reviewed and provided feedback on Level 1 and Level 2 student materials. The project subsequently revised the Level 1 curriculum. In Year Three, we are providing a follow-up review of the Level 1 student materials. This memo provides formative evaluation feedback on Level 1 Session 5 and Session 6. At your request, we also provide considerations that apply to all of the sessions for using the printed materials, computer-based Jupyter activities, and facilitator guidance.

Our Year Three review focused on the curriculum's alignment with conceptual frameworks for effective instruction and equity, as well as its potential to be adopted by other users (e.g., teachers). The frameworks for effective instruction and equity are shown in Figures 1 and 2. Throughout the memo, we reference elements of the frameworks, typically in parentheses following a recommendation.

Framework for Evaluation: Elements of Effective Instruction

1. Motivation
2. Eliciting students' prior knowledge
3. Intellectual engagement with relevant examples, applications, and models
4. Use of logic and reasoning to make, defend, critique, and evaluate claims
5. Sense-making

(adapted from Banilower et al. 2010)

Figure 1

Frameworks for Evaluation: Equity

Four dimensions for addressing equity (Gutiérrez 2009)

1. Access: resources available to students for learning disciplinary content and practices
2. Identity: appropriate attention to students' personal identities and cultural backgrounds and to the "balance between self and others"
3. Achievement: results that students achieve
4. Power: social transformation including, at the classroom level, whose voices and ideas are acknowledged and acted upon

Equitable classroom practices (Moschkovich 2013)

1. Cultural context: ensuring that classroom activities are connected to students' local communities
2. Social organization: practices that facilitate students' participation in the classroom, including attention to similarities and differences between definitions of appropriate participation at school and in students' homes
3. Cognitive resources: enabling students to use their prior knowledge and experience, including language, as resources for learning

Figure 2

The remainder of this memo provides considerations for using the different types of curriculum materials, followed by feedback for Session 5 and Session 6. The structure of the feedback for each reviewed session is as follows: an overview outlines strengths of the session and general ideas for further enhancing the materials. We then give activity-specific suggestions for increasing the alignment between the materials and the conceptual frameworks. Our intention was to make it easy to navigate between our suggestions and the materials, even though this arrangement led to repetition of some suggestions.

Considerations for Cards, Jupyter, and Facilitator Guidance

In thinking about how you could use the three formats comprising the materials to the greatest advantage, we considered your intentions in moving from the earlier printed materials to the activity cards and Jupyter as well as your intentions for how students will learn in AOLME. Our understanding is that you moved to the card format to streamline instruction for students and to emphasize the "challenges" that students are asked to address in their groups. The move to Jupyter was intended to maintain students' focus on the computer by decreasing the need for printed instructions. More generally, you intend that students will engage in student-directed experimentation with the programming commands they have learned—that is, to play—and will collaborate with each other. Your design also includes facilitators and co-facilitators who are present throughout groups' work and can provide guidance and answer students' questions.

Based on our understanding of your intentions, it appears that the cards should:

- motivate students,
- give essential getting-started information, and
- provide writing and discussion prompts.

And the Jupyter materials should:

- introduce new syntax,
- lay out the steps of computer-based activities, and
- provide a setting for students to play with commands.

The facilitator role is to promote collaboration, encourage discussion, and help students move ahead in ways that keep the intellectual effort with students. Facilitator guidance should therefore include suggested questions or actions facilitators can take and distinctions between information they can simply give students and ideas they should encourage students to grapple with.

Based on our review of the materials with these intentions in mind, we recommend that you:

- Use your goals for what students will gain from an activity to distinguish ideas students need to grapple with themselves and incidental information that can be presented in the student materials or identified in the facilitator guidance materials. For example, in a recent call, you mentioned our feedback about the use of the notation "!" to mean "not," and wondered whether you should develop an activity to help students understand the concept of negation. If developing a deeper understanding of what negation means was a goal for the program, then such an activity would be appropriate. Otherwise, it may be more appropriate to alert facilitators to the use of notation that is likely to be new to students and suggest they ask students what they think it means or how they would write it in a mathematics class. Or, if even that degree of attention will be distracting, you could include a note in Jupyter that "!=" is a different way to write "≠" or "does not equal."

- Consider including on the cards the minimum information students need to begin tackling a challenge. For some computer-based activities, that information may be a goal and a link or command that will get them to computer-based materials that are self-explanatory. For discussion or writing activities, that information may be a prompt or question.

- Consider removing any non-essential questions and any information that students can figure out through experimentation from both the cards and the Jupyter materials. Hints and suggested questions could be moved to facilitator materials to help them provide assistance without unintentionally taking over the intellectual work.

Session 5

Overview

Session 5 includes motivating elements related to creative self-expression and a game-like element to the partner work in activity 5.2. In addition, the session includes substantial opportunities for students to engage with examples and different representations, leading to Python code, related to creating black and white pixelated images. The session includes several opportunities for students to make claims and justify their ideas; you might consider adding prompts inviting students to evaluate their own and peers' claims. The session includes sense-making prompts designed to help students make connections between mathematics and computer science.

Session 5 has substantial attention to students' identity development through opportunities for both individual and group self-expression. The session also includes attention to access; you could further enhance student access by clarifying some questions and reducing potential points of confusion. You could further enhance equity with more explicit attention to achievement, power, and cultural context in this session.

Suggested Revisions From Detailed Review

5.1 Creating Images w/ the "Binary Image Generator"

a. Programming a self-selected image may motivate students to learn the programming concepts and provides an opportunity for self-expression (motivation, engagement, identity).
   - ➢ Consider focusing on the image creation task and presenting information in Sections 1 and 2 as support for creating the image

b. One version of Section 1 provides two alternative routes for accessing the Binary Image Generator, which some students may find confusing (access).
   - ➢ Consider giving students instructions for one means of accessing the Binary Image Generator, as shown on the later version of the 5.1 card

c. The question "What are the 'i' and 'j' for?" in Section 2 is unclear and could confuse students (access).
   - ➢ Consider rephrasing the question to more directly target the intended takeaways or, if not essential, eliminating this question

d. The numeric grid in Section 2 duplicates what students see in the Binary Image Generator, but is harder to read than the on-screen version (access).
   - ➢ Consider using a different example (i.e., not vertical stripes) that provides students with new information
   - ➢ Consider using a smaller example that is easier to read

e. Questions in Sections 2, 3, and 4 prompt students to consider the relationships between the numeric grid, the pixel representation, and Python code (use of logic and reasoning to make, defend, critique, and evaluate claims; sense-making).
   - ➢ Consider combining the questions to reduce text on the cards

f. In Section 4, students are prompted to make and explain a claim about the using the Binary Image Generator to make a circle or round corners (use of logic and reasoning to make, defend, critique, and evaluate claims).
   - ➢ Consider providing important takeaways in the facilitator guidance related to creating rounded images using pixels

5.2 Using Coordinates in Black & White Images

a. The question "Remember the 'i' and the 'j' we used? How are these a coordinate plane?" in Section 1 may confuse some students (access).
   - ➢ Consider rephrasing the question to more directly target the intended takeaways or, if not essential, eliminating this question

b. The question "How is this coordinate system different from what you have studied before?" in Section 2 prompts students to contrast related ideas in mathematics and computer science (prior knowledge, sense-making).

- Consider rewording the question to more directly identify the contrast students should discuss, "How is this coordinate system different from what you have studied in math class?"
- Consider identifying important differences in the facilitator guidance (e.g., the "origin" is the top left corner rather than the bottom left corner of the first mathematical quadrant, or the middle of the screen; the vertical direction is listed first in the coordinate pair; the pixel system uses only whole numbers, not rational numbers or negative integers)

c. Students may be confused because the hand in Section 2 appears to be pointing to one pixel 4R – 3C and the instructions say "name each pixel like this: 1R – 3C" (access).
   - Consider using the cell that the hand is pointing to as the example for how to name cells

d. The question "Would there be a way of telling your partner the information for your image in a briefer way? (other pairs)" in Section 4 may confuse students because the parenthetical hint suggests that the answer is still in the form of ordered pairs specifying single pixels (access).
   - Consider omitting the parenthetical hint
   - Consider suggesting to facilitators that they watch for instances in which a student describes a range of pixels rather than individual pixels; have facilitators direct students' attention to the question at that moment and, if necessary, prompt the student to restate the range description
   - Consider providing students with a rectangular region and asking the question about the rectangular region rather than students' images

5.3 Programming images with Python

a. Students may be confused about which codes are being referenced by the question "What do these codes do?" in Section 1, in part because the actions of the codes shown in Section 1 are described on the card (access).
   - Consider clarifying the question by listing specific codes
   - If the codes are those shown in Section 1, do not identify what they do as part of the text on the card

b. In Section 2, students are prompted to discuss their reasoning about predictions but are not explicitly told to test the predictions (use of logic and reasoning to make, defend, critique, and evaluate claims).
   - Consider telling students to try out their predictions and, if they are incorrect, analyze why their prediction was not accurate

c. Students may be confused by what "it" refers to in the question "What does it do?" in Section 3 (access).
   - Consider making the question more specific
   - Consider including facilitator guidance that identifies the intended takeaways

Session 6

Overview

Session 6 includes substantial opportunities for students to engage with examples, applications, and models related to grayscale and color hexadecimal code. The session also includes a number of sense-making prompts designed to help students understand grayscale and color hexadecimal code, although Card 6.3 might be improved with a sense-making prompt. In addition, you might consider adding discussion prompts to more explicitly elicit students' prior knowledge and highlight similarities and differences between computer programming ideas they are learning and their prior knowledge in mathematics. Although the session includes some opportunities for students to make claims and justify their ideas, you also might consider increasing those opportunities and adding prompts for students to critique and evaluate their peers' claims.

Session 6 also includes attention to students' cognitive resources and their access to computer programming ideas. You could further enhance student access with greater emphasis on sharing work equally within the groups and including facilitator guidance for addressing potential points of confusion. Students have opportunities for identity development and incorporation of their cultural context through self-expression in the pictures they choose and how they create them. However, you could attend more explicitly to achievement, power, and social organization in this session.

Suggested Revisions From Detailed Review

6.1 Creating Images w/ the "Image Generator"

a. The prompt "Have you ever mixed colors?" elicits students' prior experience with mixing colors, but there is no explicit prompt for students to compare this knowledge to how color works on the computer (eliciting prior knowledge, cognitive resources, sense making).
    - Consider including guidance for facilitators for leading a discussion comparing and contrasting color mixing in students' prior experience (e.g., in art class) and on the computer.
b. The prompt "Why does this RGB value give you red?" gives students an opportunity to justify a claim, but there are no explicit prompts for students to make claims or critique their peers' claims. In addition, the relationships between images and code that students are intended to discover are not identified for facilitators (use of reasoning to make, defend, critique, and evaluate claims; sense making).
    - Consider including sample questions facilitators can use to encourage students to defend and critique claims about coding color.

- Consider describing the relationships between images and code in the facilitator guidance.

c. The card does not include explicit prompts for students to take turns or enact particular roles within the group (access).
   - Consider adding suggestions to take turns on the cards or in the facilitator guidance.
   - Consider specifying student roles for the activity.

6.2 Images & Numbers

a. The third activity asks students to convert 3 numbers into binary and hexadecimal but does not include a reason (motivation).
   - Consider providing motivation for converting the numbers into binary and hexadecimal, perhaps by moving the discussion question "Why are hex numbers (not binary) used in Python code?" before the third activity.

b. The card gives students several opportunities to make and justify claims, but there are no explicit prompts for students to critique their peers' claims. In addition, the important takeaways are not identified for facilitators (use of reasoning to make, defend, critique, and evaluate claims; sense making).
   - Consider including sample questions facilitators can use to encourage students to defend and critique claims.
   - Consider listing important takeaways in the facilitator guidance.

g. Students may struggle to answer "Full **RGB** values make white. Why?" if they are focusing more on the physical colors than the hex codes for the colors (access).
   - Consider asking facilitators to prompt students to think about the hex code when answering this question if students get stuck. You might consider adding this guidance to the existing facilitator note, "Activity 6.1 was to think about the components or colors to be combined to create another color, but this activity is to think about the RGB numerical values."

c. The card does not include explicit suggestions for students to take turns or enact particular roles within the group (access).
   - Consider adding suggestions to take turns on the cards or in the facilitator guidance.
   - Consider specifying student roles for the activity.

6.3 Processing Real-life Images with Python

a. Students may be unfamiliar with the terms "proc ng," "array," "range," and "argument" in a computer programming context (access).

- Consider expanding the existing facilitator note, "make sure that the teams change picture and are able to name and use arrays, ranges, and arguments," to include specific questions designed to elicit:
  - What it means to process an image on the computer;
  - What an array, range, and argument look like in the code and how they function; and,
  - how the terms "processing," "array," "range," and "argument" differ in everyday English and in computer programming.

b. Facilitators are directed to have students take notes on what they discover when modifying and analyzing the code, but the important takeaways are not identified (sense making).
   - Consider listing important takeaways in the facilitator guidance.

c. Facilitators are prompted to elicit students' prior knowledge about degrees, but the intended connections students should make between their prior knowledge and the code are not identified (eliciting students' prior knowledge, cognitive resources).
   - Consider listing connections students should make in the facilitator guidance.

d. The card does not include prompts for students to make claims or critique their peers' claims (use of reasoning to make, defend, critique, and evaluate claims).
   - Consider including sample questions facilitators can use to encourage students to make, defend, critique, and evaluate claims about processing images.

d. This card does not include a journal or discussion prompt after the final activity (sense making).
   - Consider adding a journal or discussion prompt at the conclusion of this activity to help students solidify their learning.