TO: AOLME Project Leaders

DATE: January 30, 2019

FROM: HRI AOLME Evaluation Team

RE: Formative evaluation feedback on Level 1 Sessions 3 and 4

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 3 and Session 4. As directed by Sylvia, we did not consider the facilitator guidance for Session 4 in this review because it is under construction.

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 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.

Session 3

Overview

Session 3 includes substantial opportunities for students to engage with examples, applications, and models related to loops, conditionals, and moving a sprite. In addition, the session includes sense-making prompts designed to help students understand specific computer science concepts and terms and make connections between mathematics and computer science. You might consider revising some reflection questions to more specifically target the session content goals. 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 3 also includes attention to access, but you could further enhance student access by clarifying some questions and reducing potential points of confusion. You could attend more explicitly to identity, achievement, power, and cultural context in this session.

Suggested Revisions From Detailed Review

3.1 Using for Loops to Create Number Sequences

a. The punctuation and layout of steps for accessing the Jupyter notebook might be confusing for some students (access).
   - ➢ Consider listing each step on a separate line to reduce text and distinguish the separate steps, as shown below

     Access the **Jupyter** notebook through the terminal >_:
     - Type **`jupyter notebook`**
     - Click **`enter`**
     - Go to the directory **`/home/pi/AOLME/Session 3/`**
     - Open the file **`Session 3-Loops`**

b. There appears to be a missing or extra word in AOLME's speech bubble in Section 1 in the phrase "under title of activity 3.1" and an unnecessary period after 3.1.
c. The word "syntax" (Section 3, various Jupyter CELLs) may be unfamiliar to students (access).
   - ➢ Consider including a prompt for students to develop a definition of "syntax" in the context of computer programming.
d. The question "Which variables control the loop?" (Jupyter CELL C) is unclear and could confuse students (access).
   - ➢ Consider clarifying, e.g., "Which variables do you see in the loop? What does each variable do?"
e. Facilitators are prompted to have students compare the code across the cells in Jupyter, but not to have students defend or critique claims about the code. Also, the important similarities or differences 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 the code.
   - ➢ Consider listing important takeaways in the facilitator guidance.
f. The questions guiding students' analysis of a "for" loop in Section 4 may not be clear to all students (access, sense making).
   - ➢ Consider identifying the intended answer for facilitators and suggesting questions they can use to direct the conversation without telling students the answer.
   - ➢ Note: the directions in the Section 4 speech bubble are phrased as an imperative but punctuated as a question.
g. Note: there is a typo in the first comment in Jupyter CELL B: "# CELL B: This example shows a repearing code."

3.2 Guessing Numbers: Using Loops and Conditionals

a. Note: there is a typo and articles are missing in the overall note for the card, "The numbers in [the] Card match the Tasks numbers in [the] Jupyter Notebook."
b. The question "Have [you] ever seen someone giving a condition to another person?" appears to be intended to elicit students' prior knowledge, but its meaning is unclear (access).
    - Consider having students generate examples of conditional statements from everyday life before introducing the term "conditional," perhaps based on a model such as, "If you do your homework, you can hang out with your friends later. If you don't do your homework, you cannot hang out with your friends."
    - Consider including examples of different kinds of conditional statements that facilitators should recognize, e.g., "while" or "until" conditions as well as "if."
    - Note: there appears to be a typo in the phrase "we need commands of conditions" in Section 1.
    - Note: the instruction "Find the 'condition' in this code?" is phrased as an imperative but punctuated as a question.
c. The card does not clearly differentiate between "conditional" and "conditional statement," which could make the code more challenging for students to talk about (access).
    - Consider having students analyze the sample code to identify the condition, "number = = secret_number," and the conditional statement:
      if (number = = secret_number):
        print ("You guessed it!")
      print ("You win.")
d. Note: there appears to be an extra word in Section 3, "Enter, try several numbers or values."
e. The journal prompt is general and may not elicit the session learning goals (sense making).
    - Consider providing more specific prompts, perhaps using sentence starters, designed to help students make sense of for-loops and conditional statements.
f. The exclamation point, "!," is used in the code as a logical operator, but there is no prompt to discuss its function. Similarly, Jupyter CELL C appears to be the first use of the asterisk, "*," in Python code, but there is no prompt to discuss its function. (access).
    - Consider facilitator guidance for how to lead an exploration and discussion that allows students to understand the role of "!" and "*" in the code.
    - Consider facilitator guidance for helping students distinguish use of the exclamation point in everyday writing and its use in coding.

g. Facilitators are prompted to have students contrast the code across the cells in Jupyter, but not to have students to defend or critique their claims about the code. Also, the important similarities or differences 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 the code.
    - Consider listing important takeaways in the facilitator guidance.
h. Note: the blue "think" prompt in Section 4 is phrased as an imperative but punctuated as a question.
i. Facilitators are directed to "Discuss how the order of operations, grouping and definitions of variables might help solving a problem." But important ideas to push for in the discussion are not identified (sense making).
    - Consider listing important takeaways in the facilitator guidance.

3.3 Moving the AOLME Sprite with Python IDLE

a. The illustration of AOLME's movement reduces the demand of the programming task. (intellectual engagement)
    - Consider marking only AOLME's start location and end location so that students can determine the path of his movement for themselves.
b. The layout of steps for accessing the game.py file might be confusing (access).
    - Consider listing each step on a separate line to reduce text and distinguish the separate steps.
c. The roles for the writing exercise in Section 4 might be confusing.
    - Consider separating "team" and "summary expert" so that each subject is next to the relevant verb in the sentence.
    - Note: This instruction is in future tense, unlike most other instructions that are phrased as imperatives.
d. Facilitators are directed to ask questions to prompt students' thinking, but not specifically to help students make their claims more precise or justify their ideas (use of reasoning to make, defend, critique, and evaluate claims).
    - Consider providing suggested questions in the facilitator guidance that encourage students to make, defend, critique, and evaluate claims.

Session 4

Overview

Session 4 includes elicitations of students' prior knowledge about decimal and binary numbers and substantial opportunities for students to engage with examples, applications, and models related to converting between decimal, binary, and hexadecimal numbers. Although students

have opportunities for sense making throughout the session, editing some discussion and journal prompts could help to target the session goals more specifically. You might also consider including explicit motivation for learning about binary and hexadecimal numbers. Because one of the session goals is for students to identify real-world applications of binary numbers, you could increase motivation by presenting real-world applications of binary and hexadecimal numbers that connect to students' interests and cultures. In addition, you might consider increasing opportunities for using logic and reasoning to make, defend, critique, and evaluate claims.

Session 4 also includes attention to access by explicitly asking students to take turns, compare work, and discuss with their peers. However, you could further enhance student access by clarifying some questions and reducing potential points of confusion. You might also consider ways to attend more explicitly to identity, achievement, power, and cultural context in this session.

Suggested Revisions From Detailed Review

4.1 How do Decimal & Binary Numbers Work?

a. The illustration of a "Thousands" block appears to be labeled in Section 1, but the illustrations showing unit, ten, and hundred blocks are not connected to their place values (intellectual engagement with relevant examples, applications, and models).
   - Consider rearranging the illustrations to label each illustration with its place value.

b. Students may struggle to differentiate between the value of a number and how it is written in symbols, e.g., understanding that 10_2 and 2 have the same value (access).
   - Consider adding specific facilitator guidance for addressing confusion or misconceptions related to distinguishing number representations and number values.

c. The question "Why binary?" in Section 3 is unclear (access).
   - Consider clarifying what is being asked, e.g., "Why are these numbers called **binary** numbers?" or "Why is it important to understand binary numbers when working with computers?"

d. The term and concept of "exponent" used in Section 4 may be unfamiliar for students in lower grades (access).
   - Consider prompting an explicit discussion of the conceptual meaning of "exponent."
   - Consider including explicit facilitator guidance for introducing exponents to students in lower grades.

e. Students may not understand the concept of zeroes and ones turning values on or off (access).
    - Consider prompting a discussion of the similarities and differences between the mathematical idea of a digit indicating the number of place-value groups a number contains and "turning off" or "turning on" the value with bits.
    - Note: there are missing articles in the instructions for using table #4, "Complete [the] table using blocks that follow [the] pattern."
f. The visual representations of binary numbers are not analogous to the visual representations of decimal numbers, which might make comparing between number systems more difficult for students (access).
    - Consider using interlocking centimeter cubes to represent 10_2 with a 2 by 2 flat and the binary number 100_2 with a 2 by 2 by 2 cube.
g. The session does not include opportunities to make, defend, critique, and evaluate claims or for sense making (use of reasoning to make, defend, critique, and evaluate claims; sense making).
    - Consider adding questions on the card or in facilitator guidance that prompt students to make, defend, critique, and evaluate claims.
    - Consider adding a discussion or journal prompt designed to elicit the session learning goal of developing number sense across decimal and binary numbers.

4.2 Comparing Binary and Decimal Numbers

a. The visual representations of binary numbers are not analogous to the visual representations of decimal numbers, which might make comparing between number systems more difficult for students (access).
    - Consider using a 2 by 2 flat to represent 10_2 and a 2 by 2 by 2 cube to represent the binary number 100_2.
    - Note: completing table #4 is also an activity in 4.1.
b. Note: there is an error in subject-verb agreement in Section 2, "These numbers looks the same, but they don't have the same value."
c. On the worksheet, it is unclear what students are to write or draw in each cell (access).
    - Consider adding row titles so it is clear what students should write in each cell.
d. The session does not include opportunities to make, defend, critique, and evaluate claims or for sense making (use of reasoning to make, defend, critique, and evaluate claims; sense making).
    - Consider adding questions on the card or in facilitator guidance that prompt students to make, defend, critique, and evaluate claims.
    - Consider adding a discussion or journal prompt designed to elicit the session learning goal of converting between decimal and binary numbers.

4.3 Hexadecimal Numbers

a. The word "then" in AOLME's speech bubble in Section 1 is unnecessary and could be confusing to students (access).
    - Shorten the question to "How would you write 16 in Hex?"
b. The notation to indicate a number is in a base other than decimal could confuse students (access).
    - Consider including an explicit discussion prompt about what 10, 10_2, and 10_{16} mean (perhaps include a question about what 10 with a different subscript, like 10_8, would mean).
c. Students may be confused by the meaning of "worth" in the questions in Section 2 (access).
    - Consider revising the questions to use "value" (a term students used on the previous card) rather than "worth." For example: "Use decimal numbers to write the value of each number: 10 (decimal): ___ 10_2 (binary): ___ 10_{16} (hexadecimal): ____"
    - Consider having students represent each number using interlocking cubes.
    - Note: there is an unnecessary "then" in the question under the diagram in Section 2.
d. Section 3 introduces an algorithm for converting between binary and hexadecimal without a discussion for why it works (use of reasoning to make, defend, critique, and evaluate claims).
    - Consider having students generate and explore ideas for how to convert between binary and hexadecimal before introducing the algorithm.
    - Consider having students discuss why the algorithm works.
    - Consider including specific facilitator guidance for leading this discussion and addressing students' misconceptions.
    - Note: there is a comma misplaced in the callout box in Section 3, "Using table #3 create any binary numbers, you want then take turns converting them into Hex numbers."
e. The journal prompt is general and may not elicit the session learning goals (sense making).
    - Consider providing more specific prompts, perhaps using sentence starters, designed to help students make sense of hexadecimal numbers.
    - Note: there is a missing period at the end of the first sentence in Section 4.