

Alternatives to Simple Multiple-Choice Questions: Computer Scorable Questions that Reveal and Challenge Student Thinking

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When creating assessments, computer science educators and researchers must balance items' cognitive complexity and authenticity against scoring efficiency. In this poster, the author reports results from an end-of-course assessment administered to over 500 high school students in an introductory block-based programming course. The poster focuses on three atypical multiple-choice items, in which students had to select all the correct responses. The items were designed to be more cognitively complex than simple multiple choice questions while remaining easy to score. Results show that this type of item was challenging for students but was predictive of their overall performance.

Keywords: computer science education; high school; block-based programming; assessment

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Background
Assessing computer science students’ understanding is a perennial challenge. Computer science educators need to be familiar with a variety of question types and the tradeoffs inherent in different question formats.

- Typical multiple choice questions are easy to grade, but frequently inauthentic, unidimensional, and not cognitively demanding.
- Open-ended programming exercises are time-consuming and difficult to grade systematically.

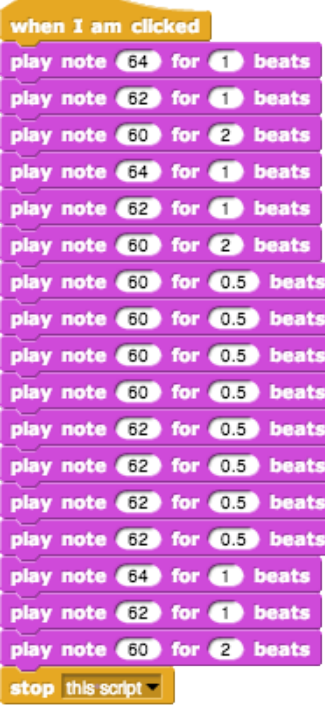
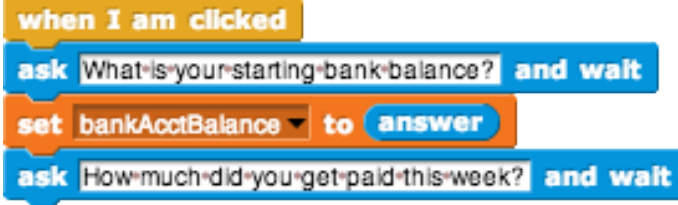
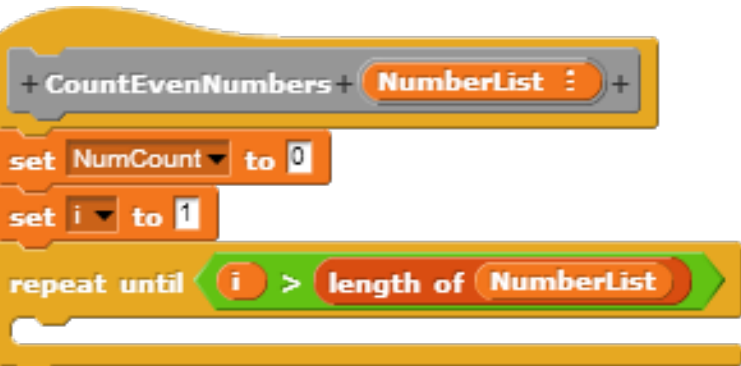
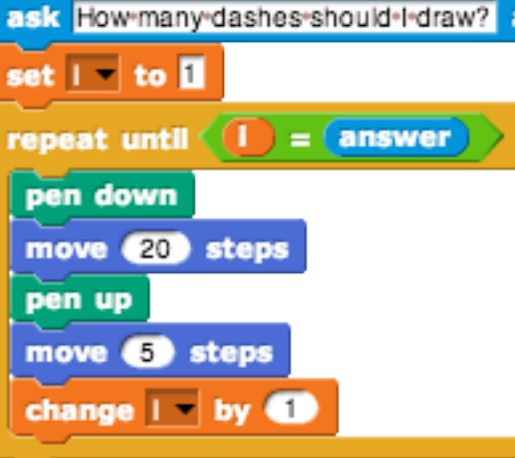
Prior work has explored how different question formats reveal different aspects of student thinking (e.g., Hazzan, Lapidot, & Raginot, 2011; Simon & Snowdon, 2014).

In this project, we explore how an atypical multiple-choice format, in which students must identify more than one right answer, may challenge students and reveal more about their thinking and understanding than a typical multiple-choice question that has only one correct response.

Method
Data were collected online as part of a larger study. The end-of-course assessment was developed specifically for the study and aligned to the introductory computer science course used in participating classes.

Classroom teachers administered the end-of-course assessment to their students as part of normal classroom activities.

Assessment Questions (percent of students selecting each answer option given in parentheses; ■ grey questions = typical multiple choice; ■ green questions = atypical multiple choice)

Question #1 Look at the two scripts below. Do they do the same thing when clicked?  ☐ Yes (37%) • ☒ No (62%)	Question #3 Alonzo started writing the below script to help him keep track of how much he has in his bank account, using the variable bankAcctBalance.  Which of the following blocks could Alonzo use next to correctly update his bank account balance after he gets paid? (Check all that apply) ☐ set bankAcctBalance to answer (5%) ☒ set bankAcctBalance to bankAcctBalance + answer (79%) ☒ change bankAcctBalance by answer (43%) ☐ change bankAcctBalance by bankAcctBalance + answer (19%)	Question #5 Evaluate the Boolean expression. ☒ not < true > or false (73%) ☐ True (27%) Evaluate the Boolean expression. ☒ true and false or false or true (65%) ☐ False (35%) Evaluate the Boolean expression. ☒ not true and not false (69%) ☐ True (31%)	Question #7 What does this mystery block do?  ☐ It subtracts 1 from all the values in MysteryList (20%) ☐ It turns newList into a clone of MysteryList (23%) • ☒ It turns newList into a reverse of MysteryList (47%) ☐ It turns newList into a clone of MysteryList, except the last item is deleted (10%)
Question #2 When the script below is clicked, how many notes will play?  ☐ 5 (4%) ☐ 6 (10%) • ☒ 8 (16%) ☐ 9 (4%) ☐ 10 (8%) ☐ 11 (6%) ☐ 12 (29%) ☐ 13 (24%)	Question #4 Alonzo wants to add some more blocks to his script so that he can also track his spending. Which set of blocks could he use to record his spending and correctly update his bank account balance? (Check all that apply) ☐ ask 'How much money did you spend this week?' and wait, set bankAcctBalance to answer (7%) ☒ ask 'How much money did you spend this week?' and wait, set bankAcctBalance to bankAcctBalance - answer (80%) ☐ ask 'How much money did you spend this week?' and wait, change bankAcctBalance by answer (14%) ☒ ask 'How much money did you spend this week?' and wait, change bankAcctBalance by answer x -1 (38%)	Question #6 The below script, when complete, should return the number of even numbers in the list NumberList. Which set(s) of blocks could go inside the repeat block to complete the script? (Check all that completely complete the script)  ☒ if item i of NumberList mod 2 = 0: change NumCount by 1, change i by 1 (52%) ☐ if item i of NumberList // 2 = 0: change NumCount by 1, change i by 1 (25%) ☐ if item i of NumberList mod 2 = 0: change i by 1, change NumCount by 1 (21%) ☐ if item i of NumberList mod 2 = 0: change NumCount by 1, change i by 1 (26%)	Question #8 The below script is supposed to ask the user for a number and then draw that number of dashes. Does the script work? If not, how can you fix the script without rewriting it? (Check every fix that works)  ☐ The script works (20%) ☒ At the beginning of the script, set i to 0 instead of 1 (53%) ☒ Set the repeat block to repeat until i > answer (30%) ☒ Set the repeat block to repeat until i = answer + 1 (22%) ☐ Move the change block to just before the pen down block (17%) ☐ At the end of the repeat block, change i by 2 instead of 1 (5%) ☐ Move the change block after the repeat block (10%)

Student Characteristics			
Gender			
Male	73%	Female	27%
Ethnicity		Grade Level	
White	44%	9th	18%
Asian	27%	10th	29%
Hispanic	26%	11th	33%
Black	2%	12th	20%

Assessment Statistics ($\alpha = 0.64$)			
#	Accuracy*	Item-Total Correlation	α if Dropped
1	65%	0.44	0.61
2	16%	0.38	0.61
3	34%	0.75	0.54
4	32%	0.72	0.54
5	69%	0.37	0.62
6	37%	0.36	0.61
7	46%	0.42	0.62
8	11%	-0.11	0.69

*Students were only given credit for a question if they answered all parts correctly (no partial credit).

Conclusions
• The atypical multiple-choice questions on the assessment were more difficult than the typical multiple-choice questions.

• Students were more likely to identify the first correct response on an atypical multiple-choice question than the subsequent correct responses.

• One of the atypical questions (#8) performed quite poorly while two of the atypical questions (#3 and #4) outperformed all the other items.