

Suitability of SCS1 as a Pre-CS2 Assessment Instrument: A Comparison with Short Deliberate-practice Questions

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ABSTRACT

In an entry-level programming course, the instructor needs to assess students' prior knowledge or to evaluate their learning at important milestones. The Second CS1 Assessment (SCS1) is one of the best-known validated tests of programming knowledge. It is a multiple-choice test written in pseudo-code, covering concepts commonly presented in Computer Science 1 (CS1) courses. However, SCS1 is known to be an unwieldy assessment – the questions tend to be difficult and thereby may not provide good discrimination between students with average competencies against the weak ones. In our project, we created a set of short deliberate-practice questions for CS1 topics and used them to evaluate students' prior knowledge at the beginning of a Computer Science 2 (CS2) course. This set of deliberate-practice questions consists of 127 multiple-choice questions.

Both SCS1 questions and our short deliberate-practice questions were given to CS2 students as pre-CS2 assessments on an online practice system called HawkQB. Using Item Response Theory (IRT), we analyzed students' responses in both sets of questions as pre-CS2 assessments to examine whether the SCS1 questions are suitable to be used as a pre-CS2 assessment instrument. We found that the SCS1 questions are of greater difficulty and low discrimination compare with our short deliberate-practice questions based on the data from students in four sections of CS2 in fall 2019. Considering the time gap between CS1 and CS2 may vary, we question the suitability of

SCS1 as a pre-CS2 assessment used in a formal test setup in the first or second week of CS2 courses.

CCS CONCEPTS

- Social and professional topics → Student assessment

KEYWORDS

CS1-CS2 Transition, SCS1, Assessment, Deliberate Practices

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1 INTRODUCTION

In higher education, instructors use assessments as instruments for evaluating and documenting the nature, quality, or ability of students. Assessment is essential both within a course or in the transition between two courses if one is a prerequisite course of another. In our context, we focus on the transition between CS1 and CS2 courses. CS1 and CS2 are terminologies developed initially by the ACM's 1978 Computing Curricula [1].

To access students' knowledge from CS1, instructors may give students a pre-CS2 assessment. In computer science education, there are only a few validated assessments [2], and SCS1 is one of the most commonly used assessment tools for CS1 knowledge [3]. The SCS1 is a multiple-choice exam that covers the common CS1 knowledge, but does so with a language-independent way with pseudo-code. SCS1 is considered of high validity and reliability since it has undergone iterative validations of its test scores.

2 Background and Dataset

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The data we used in data analysis in this paper consists of two parts: responses to a subset of 16 out of 27 questions in the SCS1 and responses to a set of 127 short deliberate-practice questions.

2.1 Python Version of SCS1

Considering the SCS1 questions are known to be challenging and unwieldy, a pre-CS2 assessment with those questions can be stressful for some students. Therefore, instructors of CS2 in UNC Wilmington picked 16 questions from SCS1 and “translated” them into Python versions (the CS1 is taught only in Python in UNC Wilmington). The picked 16 questions still provide reasonable coverage of core concepts in CS1, including operators, arrays, for and while loops, conditions, functions, parameters, and return values.

2.2 Short Deliberate-practice Questions

The second part of the data used in our data analysis is the responses to 127 short deliberate-practice questions. Deliberate practices provide tailored practice/assessment opportunities that focus narrowly on specific goals [4] – in our model, to assess the competencies on specific micro-concepts (a.k.a, micro-credentials) [5]. Our deliberate-practice questions are created to present the following characteristics: 1) each question should have low complexity and test basic knowledge, thereby can be answered quickly; 2) each question is created to test no more than three micro-concepts covered in CS1 (being *deliberate*); 3) the questions are written in Python so that they assess the understanding of computational thinking and competencies of Python programming.

Those deliberate-practice questions were given to students in one section of CS2 in fall 2019 as a take-home pre-CS2 assessment (four-weeks long). By spacing out the questions, the students had more chances to recall schema from long-term memory, improving the speed in which automation occurs. With each additional exposure to practice after some delay, the

durability of the schema in long-term memory can be improved and thereby, making students more competent in the CS1 concepts.

In this paper, we examined the difficulties and discriminations of the SCS1 questions and our short deliberate-practice questions using Item Response Theory (IRT) [6].

3 Data Analysis and Discussion

We are interested in the difficulties and discriminations of the SCS1 questions and our deliberate-practice questions. Fig. 1 shows the discriminations and difficulties of the questions investigated. From this comparison, we found that the SCS1 questions, when taken by the CS2 students are pre-CS2 assessment in the first or second week of the CS2 course, are likely to show greater difficulty and lower discrimination. This is the type of questions which can frustrate student, yet do not give instructors reliable information on students’ knowledge levels of CS1 concepts. We also found that among our 127 deliberate-practice questions, there are ones of low difficulty and fair or good discriminations.

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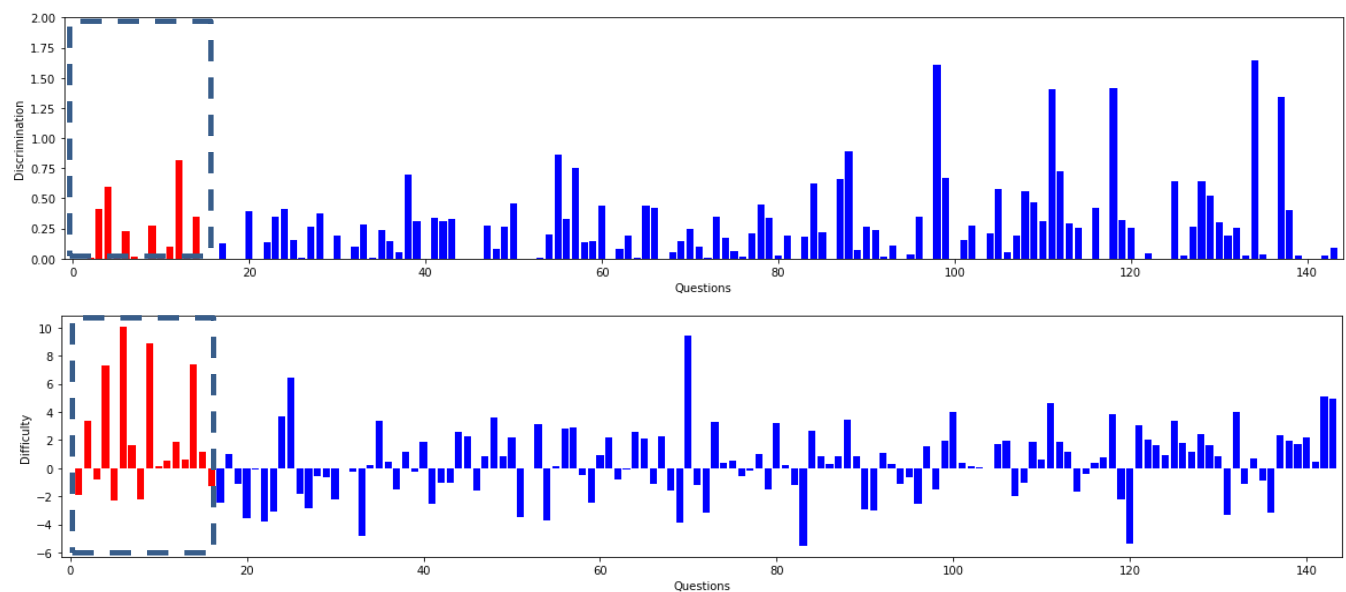


Figure 1. Difficulties and Discriminations of SCS1 Questions and our Short Deliberate Questions. Red Bars on Left Side Represent SCS1 Questions; Blue Bars Represent Deliberate Questions