Title: Computing for Change: Evaluating the Effects of an After-School Computing Program

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Short Description (70/75 words): A semester-long program evaluation was conducted to determine whether middle school students' programming knowledge and attitudes towards Computer Sciences were improved through their participation in an after-school coding program. Findings of this evaluation will be utilized to determine whether the program had efforts on students learning about programming. Moreover, findings would be used to facilitate the design of this after-school program, specifically in helping students develop interests of Computer Sciences.

Abstract (750-1000 words):

Introduction and Program Description

Computational Thinking (CT) involves skills that help children analyze and solve real-world problems drawing on computer science (CS) principles (Wing, 2006). Many children, however, experience and use new technologies in their daily lives mostly as consumers while few have opportunities to become creators of computing innovations. Further, females and non-Asian minorities are under-represented in computing professions (Cuny, 2012). One way of addressing this challenge is through the development of partnerships with both formal and informal environments, where undergraduates with CS background assist local providers. To address this gap, this evaluation study presents evidence of an after-school coding program through a university-school partnership.

This partnership aims to provide equitable approaches for broadening participation in CS in K-8 settings. In this work, we examine the semester-long, after-school coding program offered at a public school one hour every week. This program is part of a larger effort that aims to broaden participation for underrepresented groups in computing. Our approach pairs local CS teachers with undergraduate students who provide classroom support.

Towards this goal, semester-long program evaluation was conducted to determine whether students' programming knowledge and attitudes towards CS were improved through their participation in an after-school coding program, with an emphasis on gender differences. This after-school coding program, the Scratch Club, was designed to provide students opportunities to learn about programming and develop an interest in CS at Town School. In particular, this study presents one semester in which 25 students enrolled in the program with approximately 50% of girls and 50% of boys. Students who participated in the program learned about programming knowledge and CS concepts through mini-lessons and making coding projects with an online block programming tool called "Scratch."

Evaluation Questions

Process Question:
To what extent do students design coding projects during their participation in this after-

school program? Outcome Question:

Do students improve their coding knowledge and attitudes towards Computer Sciences after attending this after-school program?

The process question focused on looking at students' learning progress as they produced coding projects on Scratch. Based on the program descriptions, students spent most of their time designing and creating Scratch projects during the program. Therefore, it was important to look at how students performed in their Scratch projects as to evaluate their knowledge about coding and attitudes towards Computer Science: if students were able to create Scratch projects using different coding features throughout the program, their knowledge of coding and interest related to Computer Science should be improved. On the other hand, if students were struggling with making Scratch projects, their coding knowledge and interest of Computer Science would not have much improvement.

The outcome question corresponded to the evaluation purpose which was to determine whether students' coding knowledge and interests of Computer Science were improved through their participation in this after-school program. The outcome question was evaluated through comparing participated students' knowledge and attitude test results before and after the program.

Design and Methodology

The process question was measured by collecting and analyzing students' Scratch projects during the program. Students' Scratch projects showed how they used different programming features to create functional projects such as games, interactive stories and so forth. Examining students' Scratch projects was an important variable to determine how much programming knowledge was used by students which related to addressing the program effectiveness in helping students develop knowledge and skills about programming.

The outcome question was measured by two instruments, which were 1) Scratch Knowledge Assessment and 2) Computer Science Attitude Survey. The knowledge assessment addressed students' knowledge of the Scratch programming environment through 10 questions, including asking questions to match a Scratch script to a computing concept such as parallelism and so forth (see Appendix Three).

The attitude survey contained 36 items organized around seven constructs related to Computer Sciences attitudes, such as computing confidence and belongingness, gender and equity (Ericson & McKlin, 2012).

Students Scratch projects were evaluated using Dr. Scrtach, an automatic analytical system for Scratch projects, to analyze all students' programming projects. Dr. Scratch had become widely used in computer science education as researchers and educators examined students' coding level on Scratch (Moreno-León & Robles, 2015a, 2015b).

Students' survey data were analyzed using the dependent t-tests compare students' pre- and post-knowledge tests and surveys. Additionally, a dependent t-test was conducted to compare students' pre- and post- knowledge tests and surveys within gender groups.

Findings, Conclusions and Recommendations

Students' Scratch project analyses showed that students' prior knowledge and experience about programming in Scratch varied -- At the beginning of the program, the majority of the students had basic to developing knowledge of coding. However, students' paired programming projects which were made later in the program were found to have increased project proportions of master projects with fewer proportions of basic projects. Students' increased knowledge of programming features were found to be increased through their collaborative projects.

Students' post-knowledge test results had significant increase compared with their pre-test. This showed that they had gained knowledge of computing throughout their participation in this program.

Students' computing attitudes maintained relatively high in most of the computing constructs between their pre- and post-surveys. However, female students had significantly increased recognition on gender equity although their motivation of succeeding in computing decreased.

The program overall also helped students maintained positive attitudes towards Computer Sciences in most the CS constructs. Moreover, this program had influences on helping female students perceive gender equity in computing, although their motivations about succeeding in computing decreased. Two recommendations for actions are provided based on the findings:

1. Continue providing the program to help increase students' CT/CS knowledge.
   Students' second programming projects were found to have higher scores in most of the coding features compared with their first Scratch projects. Moreover, students' knowledge tests were found to be significantly improved compared with their pre-testing scores. Therefore, the program should be continued operating to provide students opportunities to gain coding knowledge.
2. Continue examining the program efforts on gender groups.
   The program was found to increase female students' awareness in gender equity in Computer Sciences. However, due to the fact of having a small sample size, efforts should be made to continue examining whether the program influenced students' attitudes differently on gender groups.