Effects of the 4th/5th-Grade Coder-in-Residence Program: Gigabots!

Background/Context:

Lane Educational Service District (ESD), Connected Lane County, and the University of Oregon have partnered to evaluate our Coder-in-Residence (CIR) program, a program to increase STEM identity for 4th and 5th grade students across Lane County, Oregon. The work is funded by an IES low-cost, short-duration grant (R305L180016). Our study investigates the effects on students' knowledge of coding concepts, perceptions about coding, and academic performance in related subjects. We are also investigating the effects on educators and the extent to which student, educator, and contextual characteristics moderate the relationship between participation and outcomes of interest.

Lane County has 47,000 K-12 students and 53% of them live in poverty. Data regarding post-secondary enrollment in STEM fields, industry partners' perceptions, and employment projections clearly indicate that the county does not have enough youth who are interested in or prepared to enter the STEM workforce locally and/or compete in STEM fields. Although we believe preparing youth for STEM careers would help reduce future poverty, school districts in Lane County have struggled to provide adequate opportunities in STEM subject areas. Limited access to materials and curriculum has been exacerbated by budget cuts that reduce staffing, reduce time in the classroom, and decrease spending on equipment and professional development. Not surprisingly, our students show low achievement in STEM subject areas.

While a number of efforts to improve access to STEM are underway at the secondary level, few STEM opportunities have been generated for younger students. We believe that elementary student engagement is essential to changing the STEM landscape and for creating a STEM pathway for students. This is particularly true if Lane County, and society more generally, are to reduce or eliminate the gender and racial gap that currently exists in STEM.

Intervention/program:

The CIR program was initially developed as a means to boost students' interest, engagement, and knowledge in STEM and to help students build a positive STEM self-identity. CIR matches industry representatives who have programming expertise (i.e., "coders") with elementary school teachers (i.e., "teachers") and together, these teams of educators teach a six-week, hands-on robotics and programming curriculum.

Purpose/Objective/RQ:

The research question we will investigate is: To what extent does exposure to CIR impact students' knowledge of programming and related concepts and their perceived self-efficacy in those areas? We hypothesize that students who receive CIR will demonstrate greater knowledge of coding concepts, express more confidence in their ability, and be interested in pursuing additional CS-related opportunities at a higher rate than students who do not participate in CIR.

Setting/Population/Participants:

The study takes place in 4th and 5th grade general education classes at 26 schools in 10 of the 16 Lane County, Oregon school districts. More than half of the county's students (53%) qualify for free and reduced lunch (rural districts run as high as 73%); 32% do not meet the grade level standard in 5th grade science and less than 50% meet in 5th grade math. The CIR study includes 90 teachers, 12 coders, and 1,796 students; students are the focus of this proposal.

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Research design:

The study is a school-level randomized control trial. Once schools and teachers have agreed to participate, schools are randomly assigned to the 6-week CIR program (i.e., treatment condition) or the business-as-usual control condition. Teachers assigned to the CIR condition attend two in-person professional development sessions after school. Coders also attend the second session, allowing collaborating teams to plan and prepare for the intervention.

Data collection and analysis:

During 2018-19, we implemented CIR with - and collected data from - three cohorts of students in 78 classrooms (41 treatment, 37 control). Cohort 4 implementation in an additional 12 classrooms (7 treatment, 5 control) began in September 2019.

Paper/pencil formative measures (i.e., lesson logs, student exit tickets) are administered to document – and help improve - implementation and lesson delivery, improve the program, and provide qualitative data about the experience. Paper/pencil and online summative student measures (i.e., surveys, knowledge assessments) document changes in students' interest in- and knowledge of - coding and related skills and serve as the most proximal and immediate outcomes and moderators. Assessments include multiple choice, short-answer, and logic challenge items targeting such content as math skills (used to describe the student population), coding-related vocabulary, predicted outcomes of short programs, for what purpose certain concepts might be used; and perseverance / alternative problem solving. Surveys include questions about such things as prior experience with robots and programming; attitudes towards coding, computer science, making mistakes, and working in teams; approach to challenges; interest in (hypothetical) middle school electives and robotics and programming careers; and, for treatment students, excitement and opinions about the Gigabots and CIR program. All student measures were developed as part of the Gigabots program and are administered during class by the classroom teacher.

Extant district data regarding (1) grades, (2) attendance, (3) easyCBM scores, (4) state assessment scores and (5) student characteristics serve as more distal and longer-term outcomes and variables to include in exploratory analyses. Online surveys completed by teachers and coders before, during and after professional development and implementation provide important information about context, educator characteristics, and implementation.

Analyses will be conducted in the winter of 2019, once all relevant data for the full sample of over 1,800 students is available. Our analyses will focus on students' CIR assessments and surveys. Overall student effects of the CIR program will be tested using a multilevel mixed-model ANCOVA that nests students within classrooms and schools (the unit of random assignment). The statistical model compares the two conditions at posttest using the same measure administered at pretest as a covariate, partitioning variance into three components: individuals, classrooms, and schools, which allows for a comparison of conditions while accounting for the nonindependence of observations. To adjust for the use of multiple tests, we will apply the Benjamini-Hochberg procedure (Benjamini and Hochberg, 1995).

Preliminary findings:

Preliminary reviews and analyses of surveys, lesson logs, and exit tickets indicate that participants are interested in and excited by their experience during CIR.