# PROMOTING LEARNING AND INTEREST IN MATHEMATICS FOR BLACK AND LATINX CHILDREN THROUGH CULTURALLY RELEVANT DAILY ROBOT CODING ACTIVITIES

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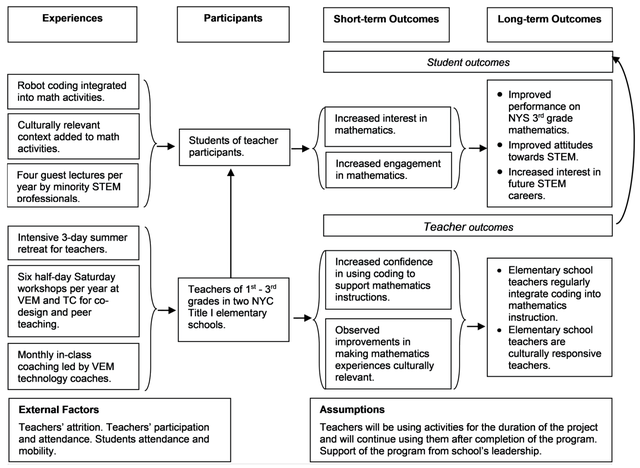
## GOALS

- Increase interest and improve achievement in Mathematics for NYC Black and Latinx students in 1st - 3rd grade
- Develop an innovative mathematics curriculum using robotics technology as a platform.

## PROJECT SUMMARY

This project focuses on this critical issue by developing innovative age-appropriate mathematics curriculum using robotics technology as a platform. Culturally relevant robot coding activities will be co-designed with teachers and implemented in their classrooms. The project is a partnership between Teachers College of Columbia University, Vision Education & Media, a community-based STEM organization, and two NYC Title I schools, that will have a direct impact on 12 teachers and over 300 students. This is the first year of the four-year project.

## LOGIC MODEL




## PARTICIPANTS

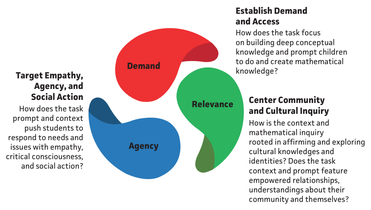
Table 1. Teacher Demographics and Students within Teachers' Classrooms

| Tch | District | Cond. | Age | Gender | Tch Race | Exp. in Years | Highest Degree Earned | Classroom | GRD | Student in Class(e) | SpEd ICT n(%) | Gender F/M(%) | Student Race | ELL n(%) | Low SES % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 (P.S.59) | Exp. | 51 | F | E | 15 | MA Early Elem. SpEd. | Gen. Ed. | 3 | 19 | 8(42%) | F(47%) | A(26%),B(5%) | 1(5%) | 100% |
| 2 | 2 (P.S.59) | Exp. | 44 | F | E | 20 | MEd. Gen. SpEd. | ICT SpEd. | | | | M(53%) | E(69%) | | |
| 3 | 2 (P.S.59) | Exp. | 43 | F | E | 19 | BA Elem. Ed. | Gen. Ed. | 2 | 26 | 11(42%) | F(65%) | A(23%),C(4%) | none | 100% |
| 4 | 2 (P.S.59) | Exp. | 41 | F | E | 0 | BA Community Health | ICT SpEd. | | | | M(35%) | D(4%),E(65%) G(4%) | | |
| 5 | 2 (P.S.59) | Exp. | 45 | F | E | 15 | MS Early Child. Ed. | Gen. Ed. | 1 | 21 | 5(24%) | F(52%) | A(33%),B(5%) | none | 100% |
| 6 | 2 (P.S.59) | Exp. | 34 | F | E | 6 | MS Early Child. Ed. | ICT SpEd. | | | | M(48%) | C(10%),E(52%) | | |
| 7 | 2 (P.S.59) | Exp. | 53 | F | E | 15 | MEd. Gen. SpEd. | ICT SpEd. | 2 | n/a | n/a | n/a | n/a | n/a | n/a |
| 8 | 2 (P.S.59) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 1 | 24 | 1(4%) | F(58%) M(42%) | A(96%),E(4%) | 9(38%) | 100% |
| 9 | 2 (P.S.59) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 2 | 21 | 1(5%) | F(57%) M(43%) | A(67%),E(28%) F(5%) | 4(19%) | 100% |
| 10 | 2 (P.S.59) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 3 | 22 | 1(5%) | F(45%) M(55%) | A(64%),E(36%) | 9(41%) | 100% |
| 11 | 1 (P.S.142) | Exp. | 31 | M | E | 8 | MA Early Child. SpEd. | ICT SpEd. | 1 | 24 | 8(33%) | F(58%) | A(71%),B(4%) | none | 96% |
| 12 | 1 (P.S.142) | Exp. | 56 | F | A | 21 | MEd. Gen. Ed. | Gen. Ed. | | | | M(42%) | E(5%),F(4%) | | |
| 13 | 1 (P.S.142) | Exp. | 47 | F | A | 24 | MEd. Gen. SpEd. | Gen. Ed. | 3 | 18 | 8(44%) | F(50%) | A(94%),E(6%) | 2(11%) | 89% |
| 14 | 1 (P.S.142) | Exp. | 38 | F | C | 9 | MA Early Child. SpEd. | ICT SpEd. | | | | M(50%) | | | |
| 15 | 1 (P.S.142) | Exp. | 34 | F | O | 8 | MA Early Child. SpEd. | ICT SpEd. | 2 | 19 | 7(37%) | F(58%) | A(69%),E(26%) | none | 84% |
| 16 | 1 (P.S.142) | Exp. | 33 | F | C | 4 | BA Child. Ed. | Gen. Ed. | | | | M(42%) | O(5%) | | |
| 17 | 1 (P.S.142) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 1 | 22 | 3(14%) | F(41%) M(59%) | A(77%),C(4.5%) E(9%),F(4.5%) O(5%) | 2(9%) | 100% |
| 18 | 1 (P.S.142) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 2 | 21 | | F(62%) M(38%) | A(76%),E(19%) F(5%) | 3(14%) | 95% |
| 19 | 1 (P.S.142) | Cont. | n/a | F | n/a | n/a | n/a | Gen. Ed. | 3 | 20 | 1(5%) | F(55%) M(45%) | A(80%),E(15%) F(5%) | 1(5%) | 90% |
| | | | | | | | | **Total** | | **257** | **54(21%)** | **F(54%) M(46%)** | **A(64%),B(1%) C(1.5%),D(0.4%) E(30%),F(2%) G(0.4%),O(0.7%)** | **31(12%)** | **96%** |

*Note*. Tch.= Teacher; P.S. = Public School; Exp.= Experimental Condition; Cont.= Control Condition; ICT = Integrated Co-Teaching; Race = Hispanic (A), American Indian or Alaskan Indian (B), Asian (C), Native Hawaiian or Other Pacific Islander (D), Black (E), White(F), Multiracial (G), Blank(O), Data not available or not collected (n/a); Ed. = education; Elem. = elementary; Child. = Childhood; BA= Bachelor of Arts; MEd = Master of Education; SpEd = special education; MA= Master of Arts; F=Female; M=Male; ELL = English Language Learner; SES = Socioeconomic Status.

## CULTURAL RESPONSIVENESS FOCUS

- Math everywhere - explore community on a "Math Walk"
- Discussion of math concepts and student engagement
- Analysis of lesson plans against CRP criteria
- Sharing mathematics stories
- Exploring student work and thinking on mathematics tasks




## TECHNOLOGY FOCUS

- Use the Finch as a tool for problem-solving, creative thinking, teamwork, and other active learning strategies
- Focus on deep understanding rather than rote memorization of math procedures.
- Use coding to support active learning of various topics in elementary school math, as an alternative to paper, pencil, more traditional rote learning methods.

## FINCH FEATURES

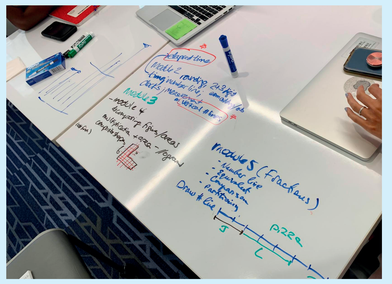
- Compatible with multiple devices.
- Accurate movement , distance, light, and orientation sensing, five programmable color LEDs, a multi-tonal buzzer, an LED screen.
- An icon-based programming environment.
- The built-in sensors to measure distances, determine robot's orientation, and compare brightness of light.
- The built-in buzzer and LEDs enable sound and light effects.

## PROFESSIONAL DEVELOPMENT

Flexible format and scheduling, e.g. in-person and virtual, synchronous and asynchronous, at schools and at the college, full day, half-day, and 2-hour.

## 3-DAY SUMMER RETREAT (AT THE COLLEGE)

- **DAY 1:** a demonstration of the robot Finch, made by Birdbrain Technologies followed by a session on culturally responsive pedagogy.
- **DAY 2:** a professional development on robot coding followed by hands-on exercises incorporating mathematics concepts with Finch.
- **DAY 3:** collaborative brainstorming of curriculum modules for incorporating both Finch and culturally responsive pedagogy into mathematics lessons.



*School year professional development sessions.*

## PD1 (FULL DAY AT THE COLLEGE)

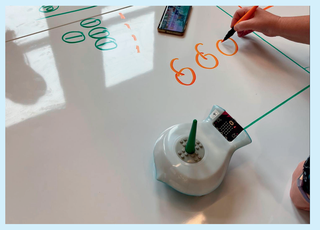
Focus on culturally responsive pedagogy:

- Exploring student work and thinking on mathematical tasks, sharing ideas about how mathematics tasks might incorporate culturally relevant pedagogy principles, and starting to design culturally relevant mathematics tasks.
- Teachers' demonstrations of completed coding tasks and discussion of robot's features that could be useful for teaching and learning mathematics.

## PD2 (FULL DAY AT THE COLLEGE)

Focus on connecting robot coding with math:

- Immersion experience with short robot coding activities for a weeklong module in the 1st grade mathematics curriculum
- Brainstorming different ideas and development and testing of mathematics tasks that could be completed with the Finch robot.



## PD3 (2-HR AT THE PARTNER SCHOOL)

Focus on co-design of activities in grade-based groups emphasizing:

- following curriculum requirements,
- developing culturally relevant context for the tasks, and
- outlining ideas for the use of Finch for each task.

## PD4 (2-HR ONLINE)

TC faculty modeled the process of revision of a draft of an activity developed by the teachers. This included:

- deepening cultural connections in the scenario of an activity,
- expanding a close-ended problem that teachers started with to a more open exploration of the topic for students, and
- making more explicit connections between the mathematics topic and use of Finch.

Following this process, the teachers worked in the grade-based groups to revise some of the drafts they developed earlier.

## SAMPLE ACTIVITY

Grade: Grade 3
Module 4: Multiplication and Area
Mathematics Topic C: Arithmetic Properties Using Area Models (Activity 1)
https://finchblox.birdbraintechnologies.com/FinchBlox.html

### My Lego Room

Alyssa and Juan are debating who's Lego room has a larger area. Juan says his room measures eight cm by six cm. Alyssa's room measures nine cm by six cm. Students will use the Finch to draw it out.

Consider the three actions that are characteristic of rich culturally relevant mathematical tasks:

- ***Demand*** - a task that provides an opportunity to explore meaningful mathematical content, allowing for students to do and create mathematics
- ***Relevance*** - a situation that attends to students' familial, cultural, and/or community backgrounds, affirming their identities and knowledge
- ***Agency*** - a situation that prompts empathy, social consciousness, and/or action

It is sometimes difficult to create tasks with all three components, so your tasks should aim for at least two of these components - *demand* and either *agency* or *relevance*.

**OBJECTIVE**

Who's room is larger, Alyssa or Juan's?

**MATERIALS**

Finch Robot 2.0
Fire Tablet
Finch Marker
Graph Paper

**MATH PROMPT**

Who's area was largest? How do you find the area of Alyssa's Lego room? How do you find the area of Juan's Lego Room? Which one measures more? And how do you know?

**PROCEDURE**

1. Turn on the Finch Robot and Fire Tablet. Open FinchBlox App. Connect the Finch to the tablet.
2. Make sure you are on Level 3 of FinchBlox (check the purple square in the top right of the screen).

**REFLECTION**

What do we know about area? How do we find the area? What are two ways that we can find the area?

## SUCCESSES

We developed a research-informed, integrated professional development model, which incorporates a variety of modalities and formats to best facilitate teacher learning and participation, including face-to-face multi-day workshops, face-to-face and online sessions in different settings, on-line support, communication and dissemination of resources, and on-site visits.
We developed a professional learning community with a partner school, and with the teachers we co-designed 13 activities for grade 1 for the module on sums and differences to 10; 20 activities for grade 2 for the module on addition and subtraction within 200 and word problems to 100; and 5 activities for grade 3 for the module on multiplication and area.

## CHALLENGES

- Teaching assignments and teacher mobility - a shortage of elementary school teachers in NYC forces the principals to move people around based on their experiences and qualifications.
- There is a struggle to sustain teacher engagement in the project between PD workshops.
- Some of the teacher participants are not open to experimentation, trial and error for themselves and their students.

## WHAT WE LEARNED

- Teachers need support to identify culturally-relevant context for the topics in mathematics curriculum.
- Teachers have positive attitudes about using robot coding technology in mathematics, but are concerned about robot capabilities to address standards-based curriculum.
- We need to maintain constant, clear and repeated communication across all stakeholders, especially with the school Principals.
- We need to have flexibility in formats of professional development to provide on-going support for the teachers.

## FUTURE PLANS

- Monthly after school workshops to continue co-design of activities with the goal to complete a total of 50 activities per grade by the end of the school year.
- Support in-between sessions via office hours hosted at the school by project mentors
- 3-day summer retreat to test developed activities before pilot implementation in the Fall 2023.
- Helping teachers to become co-designers of curriculum takes a long time.
- There is a diversity of skills, knowledge, and attitudes among the teachers, which requires more individualized support.

## ACKNOWLEDGEMENTS

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