GIRLS: Girls Immersed in Robotics Learning Simulations

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NSF GIRLS Challenge and Solution

Challenge: Interest middle-school Latina students in CS and co-robotics

Original Solution: create an in-person co-robotics curriculum with a narrative of helping a community in Puerto Rico prepare and respond to a hurricane.

Modified Solution due to COVID-19: build a **virtual** co-robotics game and curriculum to prepare and respond to a hurricane with a fleet of virtual robots and drones.
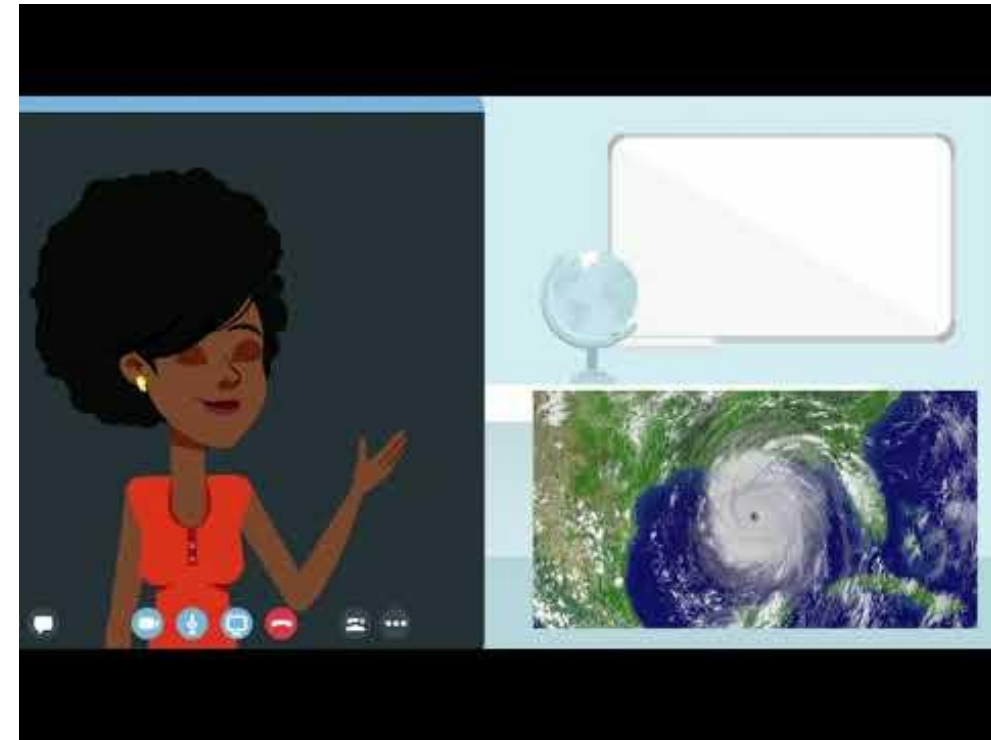

http://galeforcegame.com

GaleForce Narrative

Students join the **GaleForce Robotics Disaster Relief Team** to help San Juan, PR to prepare and recover from a hurricane.

The characters Dr. Jackson and Nalia tell the story surviving Hurricane Katrina and becoming emergency managers in PR.

Unity 3D Game

Students choose avatars and enter a 3D Unity control room to work in teams to deploy virtual robots and drones in remote-controlled or coding missions such as evacuation, delivery of supplies, clearing debris from roads, or rescuing lost pets.

Collaborative Coding Environment

The game uses a Scratch-like collaborative block-based programming environment with supports for calculating map distances.
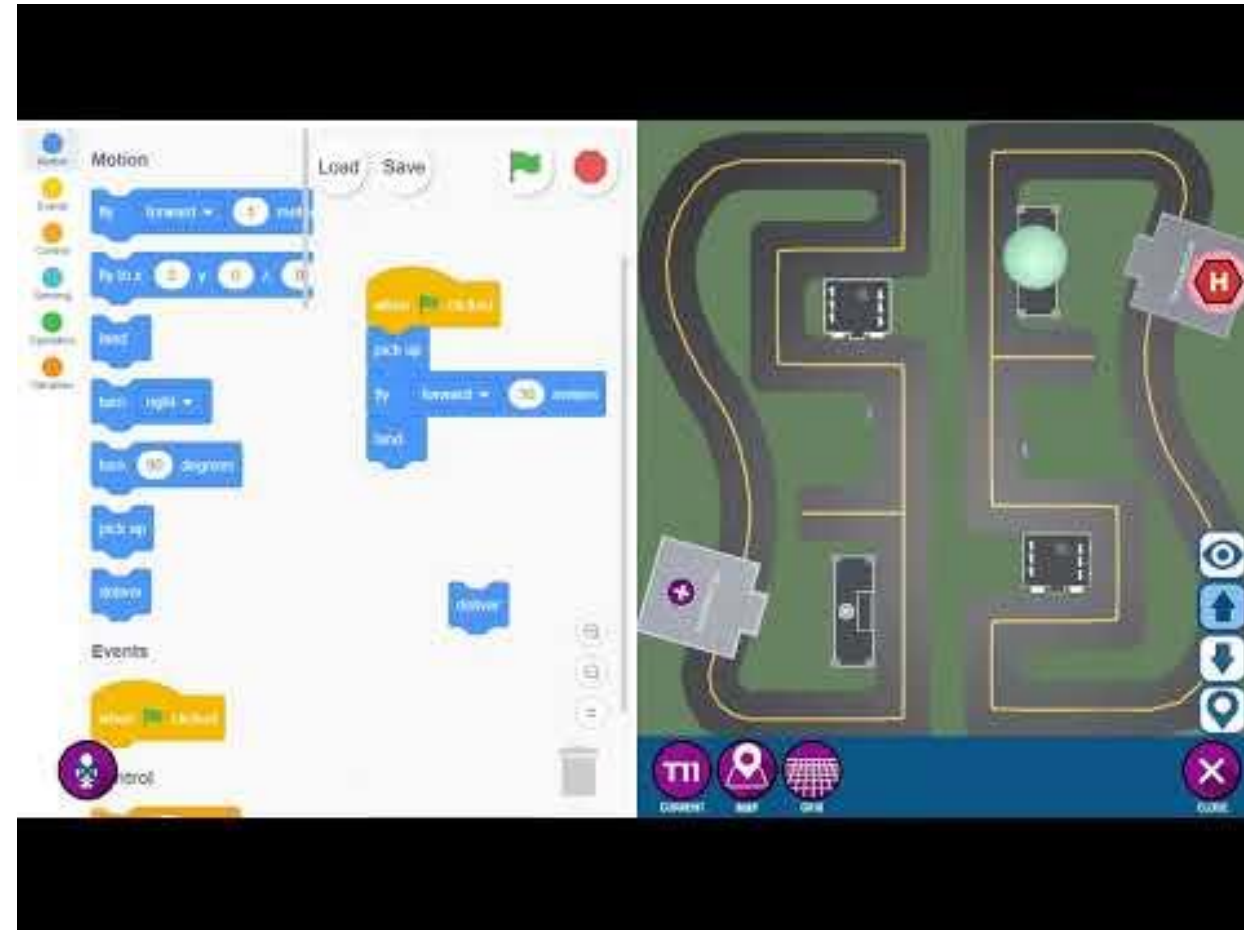
Backend Data Collection

Student code is automatically saved in a Firebase database.

Online tools allow researchers to search through the database of collected artifacts and teachers to see their students' progress.
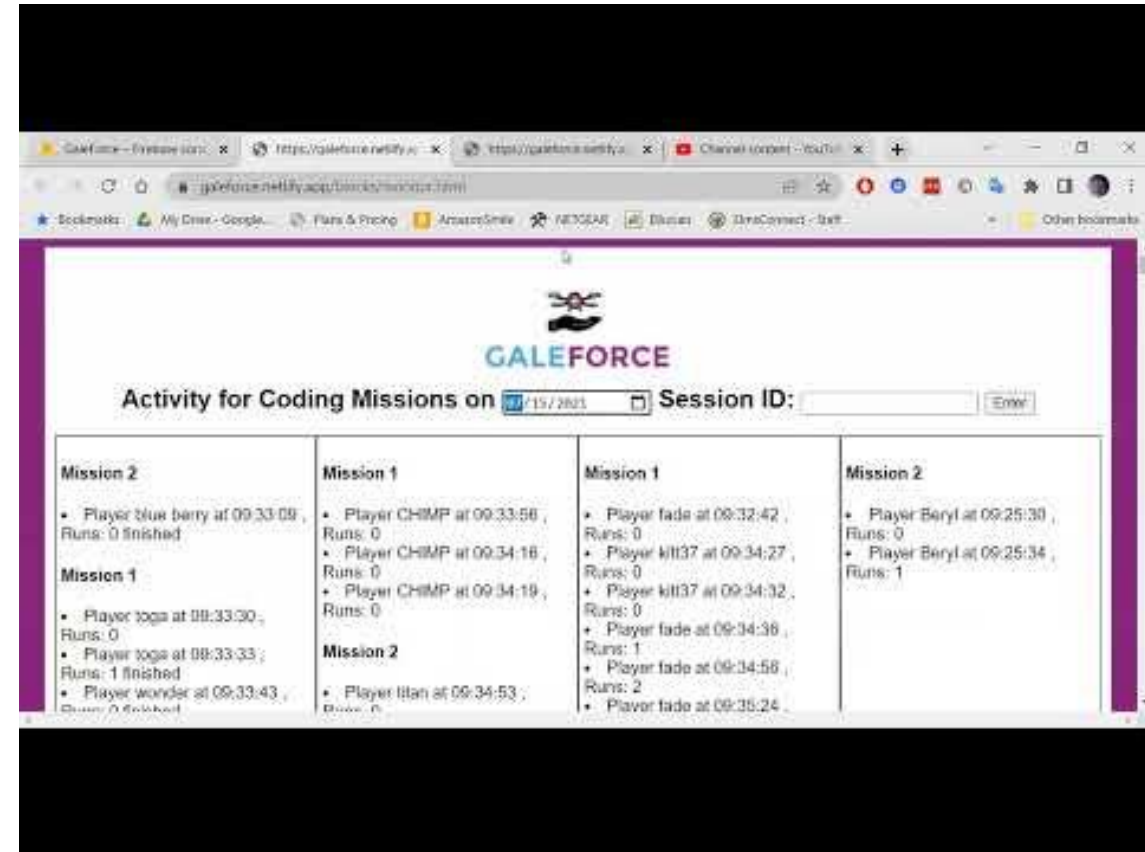
Teaching Materials

Teaching materials are available at
https://galeforcegame.com/teachers/:

- CSTA Standards
- Lesson Plans
- Slide decks
- Supplemental activities like machine learning

https://cv-recognize-objects.glitch.me/

Pilot Study Summer 2021

Research Questions:

1) Does the GaleForce Online Robotics Adventure Game lead to **higher interest and self-efficacy** in co-robotics and computer science?

2) Does the GaleForce Online Robotics Adventure Game lead to **improved student content knowledge** in co-robotics and computer science?

3) And how do children engage with the GaleForce Online Robotics Adventure Game and **collaborate with each other** in order to solve robotics challenges?

BOYS & GIRLS CLUBS
OF GREATER HOLYOKE, INC.

Participants, Setting and Data Collection

Participants and Setting

- Eleven 8-9 year old students from the Holyoke Boys and Girls Club (6 girls).
- Five day vacation camp, three contact hours per day.
- Students worked in pairs to solve co-robotics challenges.
- Only 8 students completed content and survey pre-post.

Data Collection

- Audio recordings of student collaborative discussions while solving missions.
- Completed programs.
- Pre-post robotics content test.
- Pre-post self-efficacy/interest survey.

Data Analysis

- Gain scores pre-post content test.
- Gain scores self-efficacy/interest survey.
- Descriptive analysis of completed programs.
- Codebook development for analysis of collaborative discussions.
  - Sixteen codes:
    - six CS learning codes
    - five game-based codes
    - five interaction codes

Scientific Impacts: Results

- Seven of eight students posted gain scores on the content test, ranging from 11% - 39%.
- Seven of eight students posted gain scores on the self-efficacy/interest survey from 13% - 50%.
- Students engaged productively in pair programming, with most pairs completing 12-15 missions.
- Students relied on concrete referents in the virtual world to reason about writing their programs, as opposed to in-game scaffolds.

Scientific Impact: Pre/Post Content Knowledge & Interest Survey

Table 1 - Missions Completed and Gain Scores

Avatar Name/Student Gender (F/M)	Total Missions Completed	% Gain Pre-post test	% Gain Interest in CS Survey
storm/blueberry - F	14	33.33%	25%
Nightbooks* - F	13	11.11%	25%
Toga - F	12	16.67%	19%
Wonder - F	5	16.67%	50%
Echo - M	15	11.11%	25%
Titan - M	14	38.89%	13%
Fade - M	12	-5.56%	25%
CHIMP - M	7	22.22%	-6%

Scientific Impact: Average Gains and S.D.
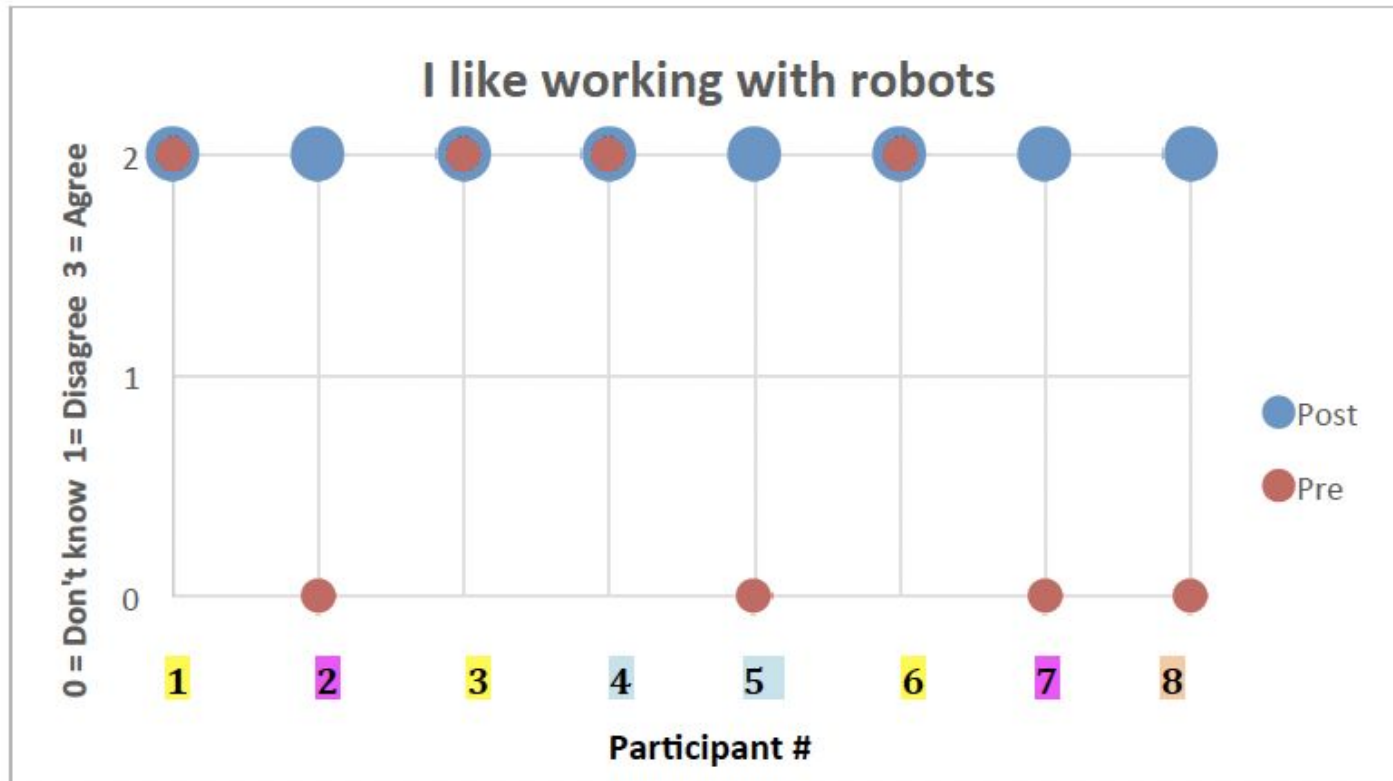
Table 2 - Average Gains and Standard Deviation

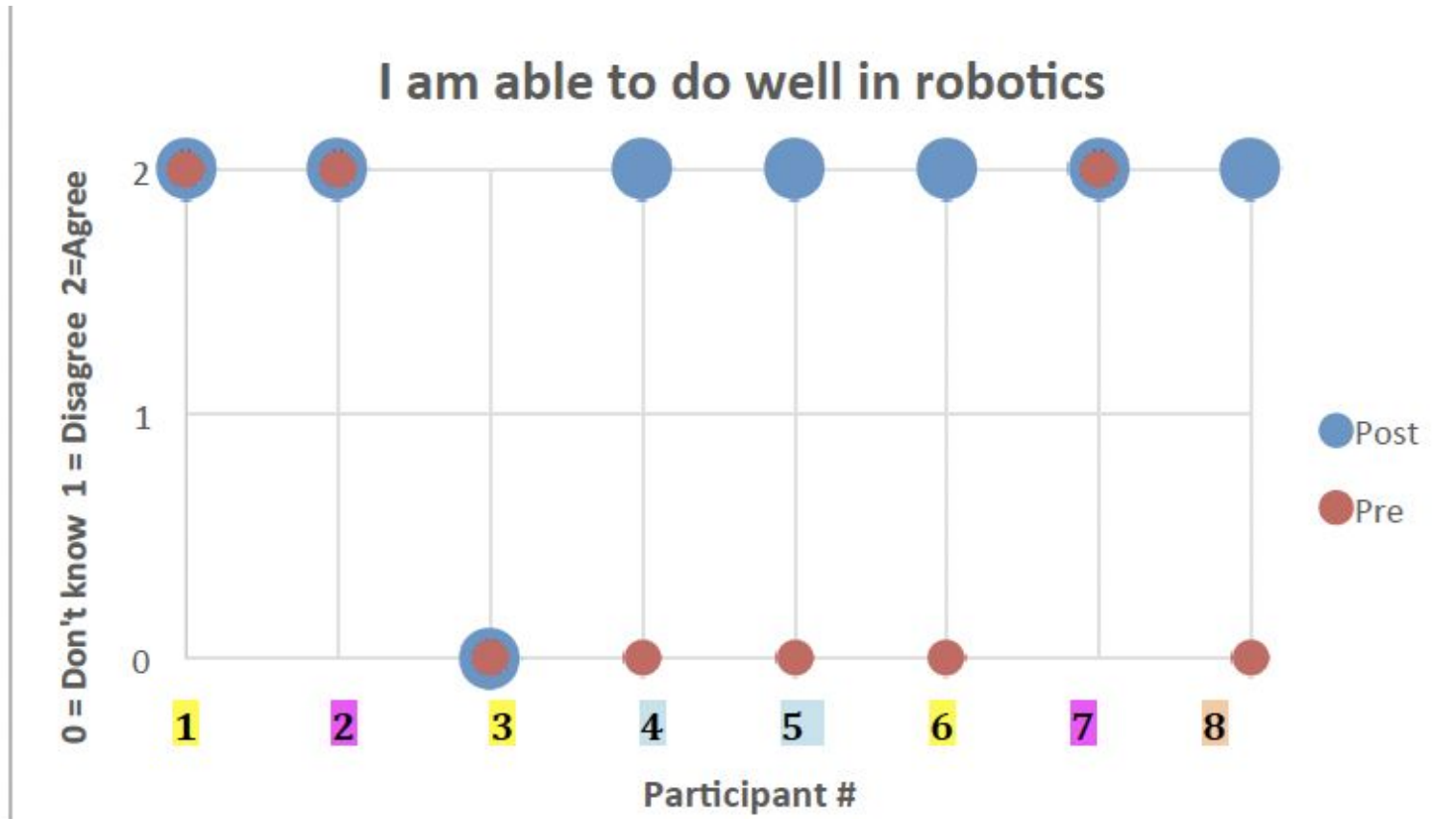|	Average Gain Score (as %) Content Test	S.D. (as %) Content Test	Average Gain Score (as %) Interest Survey	S.D. (as %) Interest Survey
Females	20.00%	8.43%	29.75%	13.79%
Males	16.67%	16.67%	14.25%	14.63%

Interest Survey Results
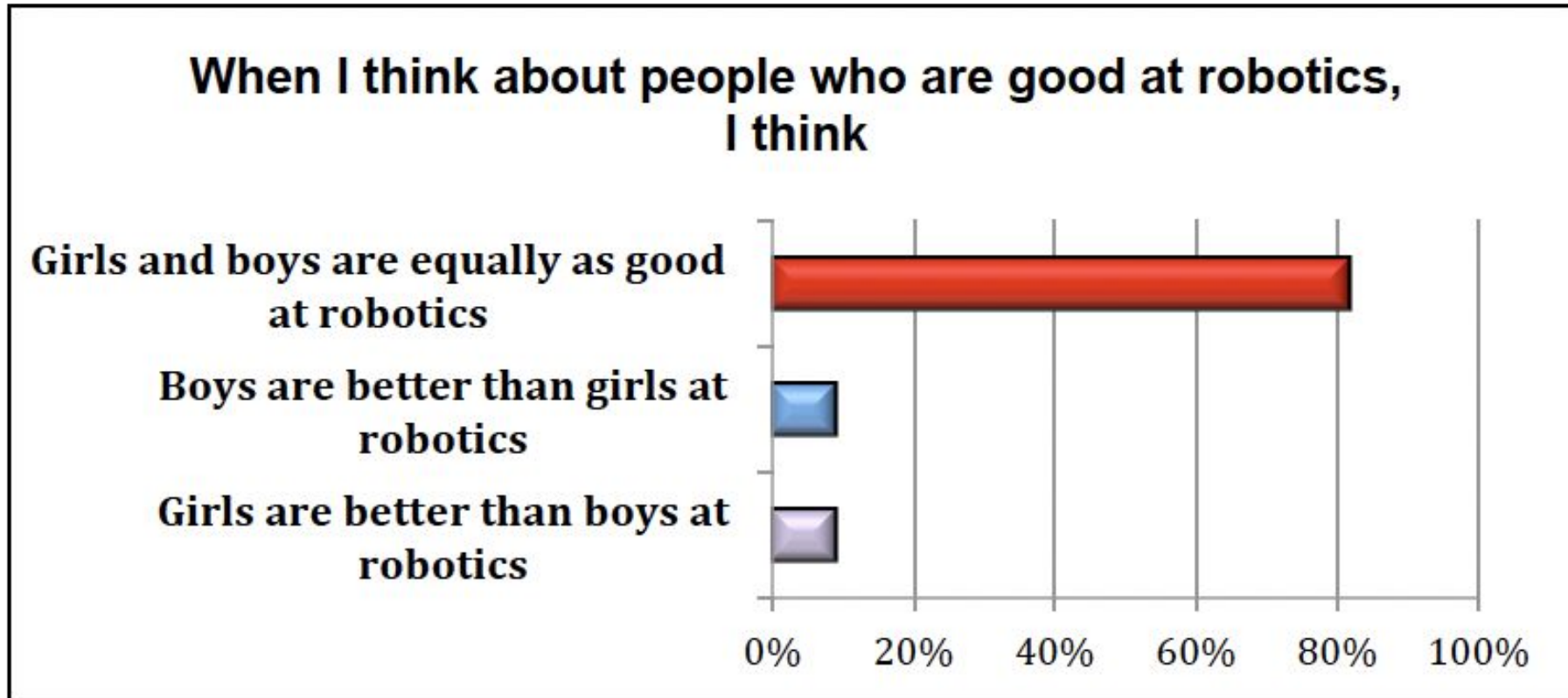
Interest Survey Results

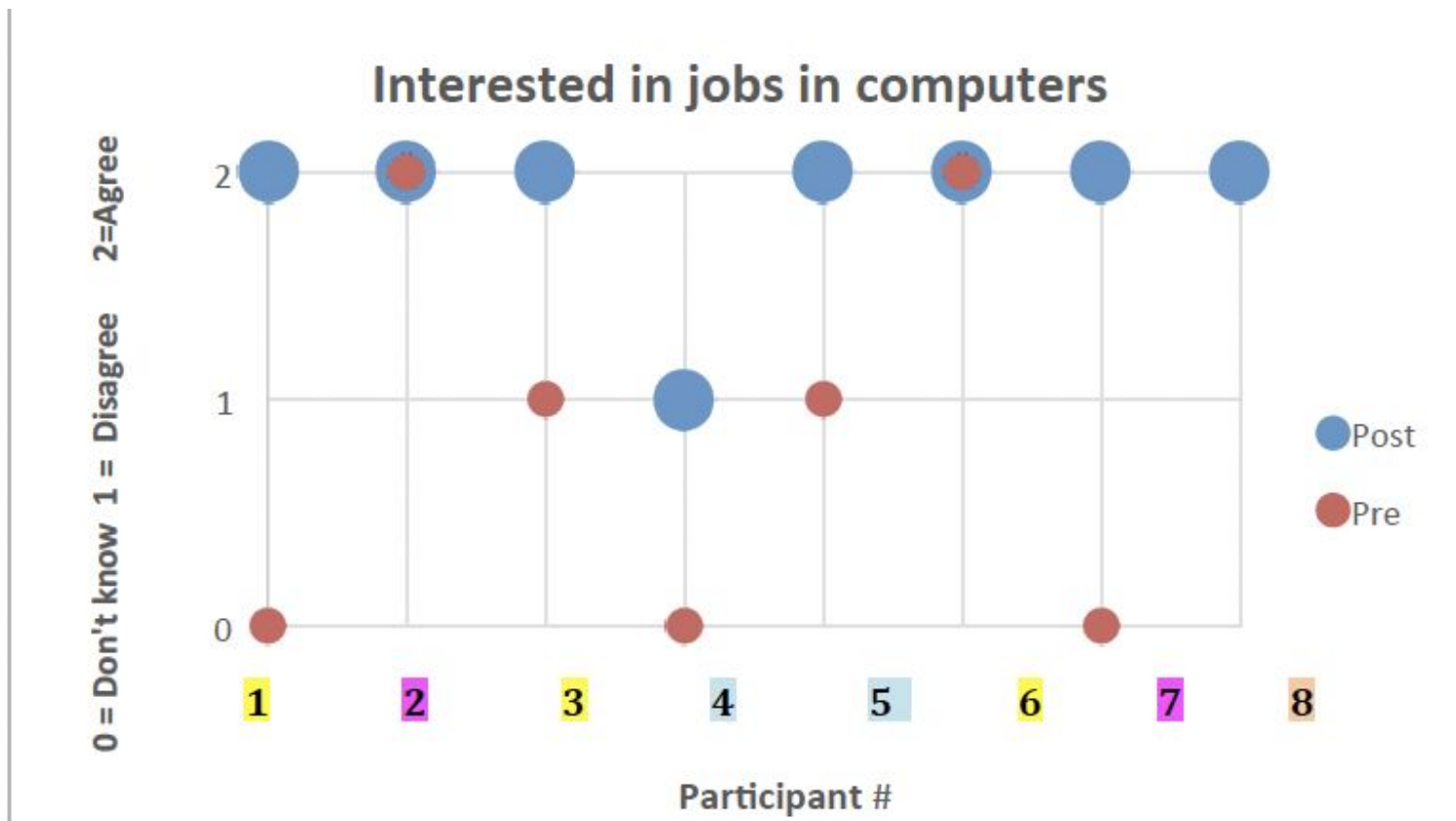Increase in post-survey "I like working with robots"

Interest Survey Results

Increase in "I am able to do well in robotics"

Interest Survey Results

Increase in "Interested in Jobs in Computers"

Scientific Impacts: Collaborative Learning

- Collaborative data analysis is ongoing, preliminary results indicate the following:
  - Over 40% of the discussions revolved around algorithmic operations and variables.
    - E: Drive forward 80.
    - T: No, we need to follow the curve for 20
  - 19% of the comments made regarded knowledge reflections indicating student awareness of possible solutions.
    - T: Don't change it.
    - E: Good, we're almost done.

Scientific Impact: Main Takeaways

Pilot Study Main Takeaways:

After Engaging with the GaleForce Game…

1) All students improved their performance on a robotics content test, with girls averaging a slightly higher gain than boys.
2) All students' interest and self-efficacy in CS improved, but especially girls, whose average interest gain was almost 30% from pre-post.
3) Students relied on the visual element of the game to reason about programming.
4) Preliminary collaborative learning results indicate that children primarily discussed the development of algorithms during pair programming.

Broader Impacts

- What is the impact on society?
  - **Broaden participation of girls and Latinx students through a first responder co-robotics game.**

- Education and Outreach
  - This is an educational game, freely available online at http://galeforcegame.com with teacher materials, outreach through CSTA.

http://galeforcegame.com