Multidisciplinary Integration and Data Science as a Means to Nurture Female Interest in Computing

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Why Nurture Positive Perceptions of STEM/Computing?

- Perceptions = Beliefs
- Perceptions and beliefs impact judgements, which in turn, influence cognitive, affective, motivational, and decision-making processes
- ➔ Building positive perceptions of computing
- Is a crucial equity issue as we strive to broaden participation
- Can be achieved through integrating CS with other subjects; developing courses that allow students opportunities to combine computer science with other subjects

Strategies for Engaging Girls in STEM & Computing

Climate Science as a Context for Disciplinary Integration

- Climate science cuts across numerous disciplines in the natural and social sciences (Hestness et al., 2018).
- Student engagement with climate science curricula has been shown to promote personal choices that reduce individual carbon emissions (Cordero et al., 2020)
- A wealth of climate and paleoclimate data are made available online through services such as the National Climate Data Center (NCDC) of NOAA
- Youth & teens today identify climate change as an issue they are deeply concerned about & also view climate change as an equity issue (it disproportionately impacts minorities and poor people).

Inter-disciplinary Connections to Earth Science & Data Science

- Data analysis and interpretation is a core science and engineering practice
- NGSS ESS3-5. *Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems*

How do you design an authentic multidisciplinary experience that will promote positive perceptions of computing?

Climate Science, Data Science, & Computing Camp

Computer Science & Data Science	Climate Science
Introduction to NetsBlox & Distributed Computing (Weather app)	N/A
Intro to 2-dimensional arrays and plotting	Intro to paleoclimate, temperature, CO2, carbon cycle
Plotting CO2 from Mauna Loa Plotting ice core data	Ice core data, d18O proxy
Data processing, computing mean and moving average	Review of proxy information, discussion and plot interpretation, Q&A
Project assignment	Project assignment
Project work & help	Project work & help
Project work & help	Project work & help
Project Presentations	Project Presentations

- Eight weekly one-hour online synchronous sessions
- 23 high school students (69% identified as female)
- Female paleoclimatologist & computer science educators
- Climate data from NOAA datasets

- 35% Hispanic or Latino (n=9)
- 31% White (n=8)
- 15% Asian (n=4)
- 8% Black (n=2)

NetsBlox as a Tool for Data Exploration & Multi-Disciplinary Engagement

About NetsBlox (netsblox.org)
- Block-based environment based on Snap!
- Open-source, web browser-based
- Provided distribute computing blocks
  - Remote Procedure Calls (RPCs)
  - Message passing
- Low-floor, high-ceiling, wide-walls

Authentic engagement in Climate Science with paleoclimatologist, Dr. Jessica Foster
1) Discussions on fundamentals of climate science with students, including the tools climate scientists use;
2) Student engagement with real paleoclimate data through visualizations and computations in NetsBlox;
3) Open-ended inquiry and introduced students to research question development, which is central to the scientific process.

Final Projects

- Original datasets and resources
- Air temperature proxy data from S. American mountain glacier ice cores, sea surface temperature proxy data from corals from the Yucatan, and climate forcing data compiled for the 2018 National Climate Assessment

Final presentations
- Explain the data archive (corals, ice cores, climate forcings),
- Talk through the data, analyses and visualizations coded in NetsBlox
- End with an original research Q that could be pursued with the data (and discussions on the qualities of good scientific research questions)
- Each group was given a set of questions to guide their research into each dataset, but beyond that, the assignment was open-ended

> I think the most interesting thing I learned, mostly just because it was a Eureka moment, was that anthropogenic forcings have clearly caused the increase in average global temperature.

Post-Survey Questions related to Student Perceptions

- What were one or more takeaways, aha-s, insights regarding computer science from this program? [Open response]
- This program expanded my views regarding how we can use programming [Slider: Definitely No (0) to Definitely Yes (100)]
- I am interested in learning more about how we can combine programming with other subjects/topics (such as climate change) [Slider: Definitely No (0) to Definitely Yes (100)]
- What are some topics you'd like to explore through programming? [Open response]
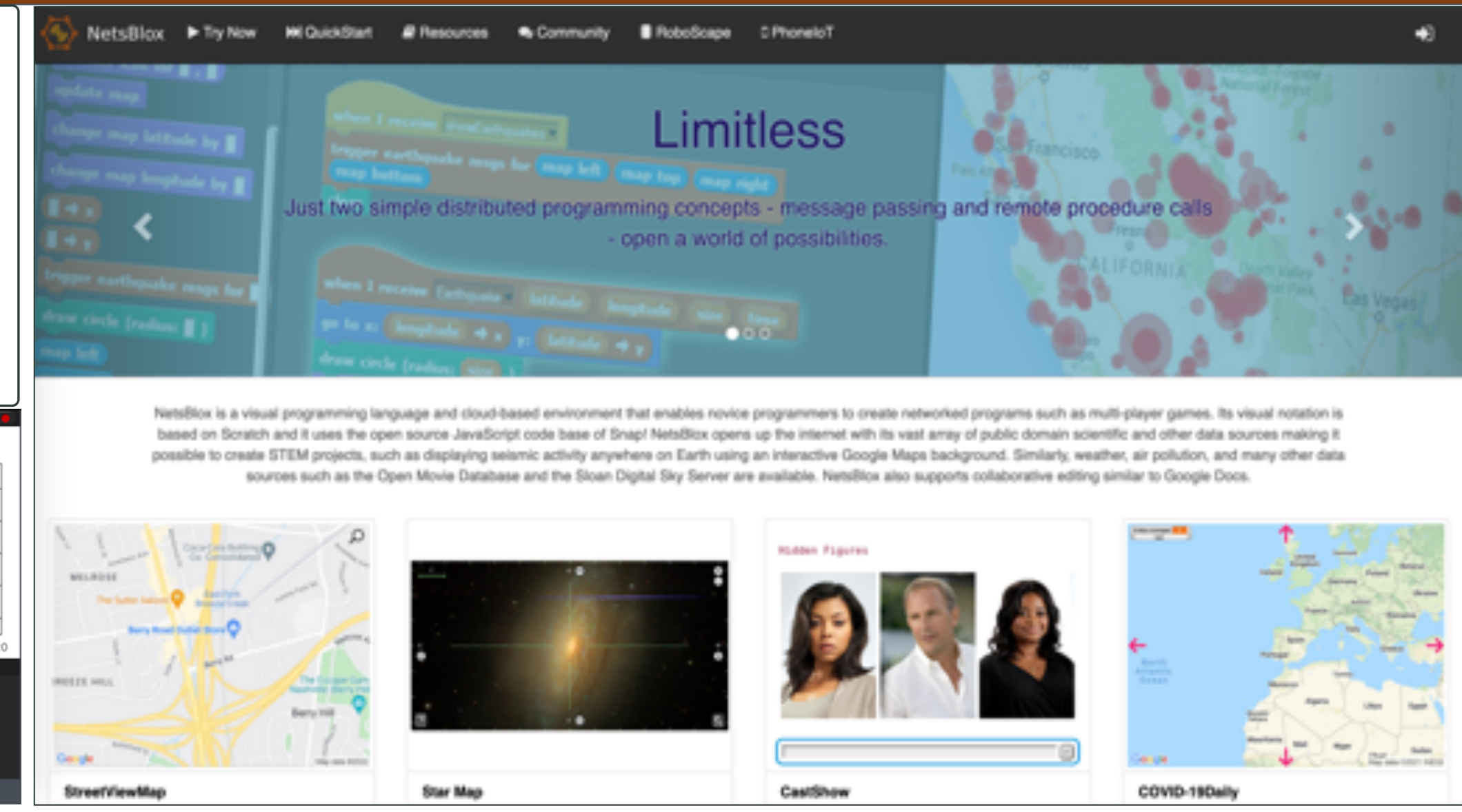
- 83% indicated the camp expanded their views regarding how they can use programming
- ~75% of students' open responses suggested the camp expanded their thinking on computing, data, & data visualization

Students Take-aways

- More to CS and/or programming than they were aware of. "You have to take your time and it requires a lot of critical thinking. There is much more to coding than moving around a character."; "Some takeaways I took from this pro- gram is that Computer Science can be used for a variety of things and not just programing."; "There is always so much more to computer science. Throughout our XYZ classes, there was always something new to learn!" "...you can use [CS] for anything. What I mean is that, in the computer science world and programs like Netsblox, nothing is really off limits. You can make things to fit your data and criteria and I think that that was very insightful to learn and discover."
- Data-related. "I thought it was interesting how you can freely manipulate data in an in-depth way and have access to a lot of data sets through computer science."; "Code can be used to pull a variety of data and condense it to be used for coding in a program."
- Data visualization. "If you have data you can make many visual representations to share that data."; "Now I know how to plot and graph data using Computer Science";
- Career. "Working through and figuring out the coding from this project confirmed for me that I want a career in STEM, and specifically, engineering."

What are some other topics you'd like to explore through programming?

I would like to explore something about population levels in different ecosystems. I have always been very interested in animals and their environment and think that it would be cool to try seeing different data with computer science to understand the effects of climate change on ecosystems.
I would like to look at the changes in the plastic in the ocean over a period of time.
I would like to research more about the health of humans and what affect humans the most.
I would like to explore how to use art, programing, and STEM ideas for a future career
Space and physics.
I would like to explore how we can use computer science to analyze human habits and psychological patterns more.
Air quality
I would like to explore ratios of vaccines and diseases using graphs.
I'd also like to learn about how programming relates to electronics and how we can use it to direct electricity.
Another topic I would like to explore through programming is the solar system.
Maybe like baseball batting averages or the WAR or Wrc+ or in football to compare QBR and to analyze data in sports using coding.
I'd like to explore extinction/decrease in animal populations.