Unveiling Voices: Boston Students' Data Activism Journey with Community Catalysts

Raechel Walker
Massachusetts Institute of Technology
raechelw@media.mit.edu

Sophia Brady
Boston College
bradyss@bc.edu

Olivia Dias
Massachusetts Institute of Technology
omdias77@mit.edu

Adriana Castillo
Wellesley College
ac131@wellesley.edu

Kaleb Asfaw
Massachusetts Institute of Technology
kda@mit.edu

Elijah Johnson
Massachusetts Institute of Technology
elijahj@mit.edu

Matt Taylor
Massachusetts Institute of Technology
mewtaylor@gmail.com

Cynthia Breazeal
Massachusetts Institute of Technology
cynthiab@media.mit.edu

Abstract—A noticeable gap exists in the availability of computing curricula tailored to empower African American students to apply their computing skills for the betterment of their communities. This research applies "liberatory computing" as a way to empower African American students in addressing embedded racism through computing. An exemplar of this liberatory computing approach is our curriculum on data activism, which uses data science to confront and mitigate systemic oppression. The study engaged 24 high school students of African American descent, who partnered with community organizations in the Greater Boston area for a range of data activism initiatives. These projects encompassed data analysis, geospatial analysis, qualitative analysis, surveys, interviews, artistic expression, and the incorporation of community perspectives. The organizers intend to use the students' projects for advocacy purposes, such as advocating for policies addressing flooding in African American and low-income Boston communities using data visualizations. The student surveys revealed heightened awareness of data science's role in combating racism and enhanced proficiency in promoting racial justice. Interviews with the students revealed that mitigating systemic oppression through their data activism projects with community organizers was a pivotal aspect that motivated them to persist in integrating data activism into their future pursuits. The implications of this research demonstrate how African American students can be empowered to utilize data science in order to catalyze societal transformation. This is achieved by fostering opportunities for them to apply their data science skills to tangible real-life issues through collaboration with community organizations addressing systemic challenges.

Index Terms—liberatory computing, activism, liberation tools, justice, broadening participation in computing, computing education, data activism, racial identity, data science, AI literacy

I. INTRODUCTION

The underrepresentation of African American students in computing is a complex issue rooted in historical factors, such as systemic racism and negative societal messages that explicitly or implicitly suggest African Americans are not suited for computing. Despite efforts, the percentage of computer science Bachelor's degrees awarded to Black or African American students has not exceeded 4% over the past few years [1], [4], [15], [19]. Furthermore, to the best of our knowledge, there is currently a lack of data science curricula specifically designed for African American high school students to address the unique and detrimental manifestations of racism and oppression they confront, such as what my data activism program does by partnering students with community organizations [6], [8], [12]–[14]. The aforementioned challenges emphasize the critical importance of developing a comprehensive framework that incorporates liberation tools specifically tailored to address the needs and experiences of African Americans in the field of computing.

Based on prior work, liberatory computing is a solution to teach students how to use computing to support minoritized groups [17]. Liberatory computing is a framework that ensures African American students acquire five pillars of the liberation framework developed by Dr. El-Amin [3]: (1) a sound racial identity, (2) critical consciousness, (3) collective obligation, (4) a liberation centered academic identity, and (5) the activism skills to use computing to transform a multi-layered system of barriers in which racism persists. We present a data activism curriculum that incorporates liberatory computing, specifically designed for African-American high school students, with the goal of empowering them to utilize data science to address systemic racism. Data activism involves using data science to challenge power inequalities, including racism [2], [7]. Schools should prioritize educating high school students about data activism before they enter college, ensuring they are well-prepared for the challenging computing curricula. This proactive approach enhances the appeal of their applications by showcasing their real-world experience.

A unique aspect of my data activism program is that students actively engaged with community organizers from the Greater Boston area, employing the Critical Participatory Action Research (CPAR) framework. This program is different from other computing curricula because it allows students

to build relationships with community leaders and make a difference in real-time. All community organizers involved have expressed their intent to leverage the students' research to strengthen and amplify their advocacy efforts in vital areas such as inaccessible housing, food insecurity, and environmental injustice. The surveys conducted after the program revealed a significant surge in the percentage of students who acknowledged the transformative power of data science in combating racism and using their academic achievements to address these systemic injustices. Interviews with students unveiled an aspiration to integrate data activism into their future endeavors, driven by their ability to effect positive change within the community through collaboration with community organizations. Student's newfound confidence will empower them to provide valuable support to their communities through data-driven insights and analysis. Specifically, we aim to investigate the following research question: "How does the acquisition of liberatory data science skills contribute to students' proficiency in each of the liberatory computing pillars?"

II. Background

A. Liberatory Computing Framework

We propose a curriculum that addresses the racist and violent history against African Americans by discussing how liberatory computing can assist African Americans in deconstructing racism. It is impossible to use computing to transform society without addressing these five pillars [18]. Although there are curricula that individually incorporate some of these liberation tools [9]–[12], [16], liberatory computing draws attention to the importance of incorporating all of these tools. Liberatory computing empowers educators to effectively teach African American students how to address institutionalized oppression while placing the African American experience at the forefront. The curriculum places significant emphasis on five fundamental principles of liberatory computing [18]:

- Sound Racial Identity: Acknowledging race as a significant aspect of personal identity, fostering a positive attitude towards one's racial group, and recognizing and addressing the adverse societal attitudes directed at that group
- Critical Consciousness: Developing the ability to analyze and resist systems of inequality, including critical reflection and action, and a heightened sense of agency
- Collective Obligation: Acknowledging membership in a group, recognizing the group's lack of power, rejecting societal justifications for this disadvantage, and believing that pooling resources can collectively overcome barriers
- Liberation Centered Academic/Achievement Identity (LCAI): Encouraging positive views of academic competence and the use of education for collective transformation
- Activism Skills: Equipping students with skills for using computing as a medium for activism, including technical skills, and socio-emotional capacities

B. Critical Participatory Action Research

CPAR is a form of collective inquiry that provides youth and adults with opportunities to identify problems and possibilities in their own communities, gather and analyze data about these problems, and take action to create positive change [5]. CPAR researchers strive to name and explore the different ways in which positionality, context, and power impact their findings. The essence of the CPAR process revolves around cultivating relationships, and within this study, both students and community organizations actively participated in activities and icebreakers designed to foster meaningful connections. After determining the research goal, students learned that creating a research question is an iterative process. They were introduced to the strengths and drawbacks of different methodological approaches to data collection, such as surveys, interviews, open data, and literature reviews. In addition, students were taught how to collect and analyze data through thematic analysis and Python. Finally, students confidently presented their research findings to a diverse group of stakeholders at two prominent research events.

C. Data Activism Curriculum Design

A total of 24 African American high school students from the Greater Boston area participated in the ten-week data activism program (Figure 1). The recruitment process involved word-of-mouth, email invitations, and a Zoom informational session to reach potential participants. In order to accommodate more students, classes were conducted via Zoom throughout the week. The students were divided into four groups for the Zoom class, with each group receiving one hour and 30 minutes of instruction during the week. After participating in virtual class sessions throughout the week, all 24 students had the chance to attend an in-person class lasting for five hours on Saturdays. This in-person session provided a valuable hands-on experience and enhanced the collaborative learning environment of the data activism program. Furthermore, the program fostered meaningful partnerships with three community organizations: Habitat for Humanity Greater Boston, Food Link, and the Charles River Watershed Association.

To comprehend the benefits of the data activism project for both community organizers and students, we gathered data from four sources: (1) Students' final projects, (2) Pre and post student survey questions, (3) Post student interviews, and (4) Post community organizer interviews. Overall, this mixed-methods study provided a comprehensive understanding of how the students actively collaborated with community organizers on their data activism projects. Also, the students underwent a set of survey questions to assess their proficiency with various liberation tools. The survey was administered to all 24 students, and 17 students responded to the survey. To determine the statistical significance of the discrepancy between certain pre- and post-survey results, we utilized the Mann-Whitney U test and the Kruskal-Wallis test. The pre-survey and post-survey were distributed through Qualtrics during class.

Week	Lesson Topic	Week	Lesson Topic
1	1. Intro to Data Activism | 1 hour 2. Intro to Intersectionality | 1 hour 3. Intro to CPAR | 30 minutes 4. Data in Google Sheets | 3 hours	6	1. Developing Research Questions | 1 hour and 30 minutes 2. Research Protocols | 1 hour 3. Research About Community Organizations' Mission | 30 minutes 4. Relationship Building with Community Organizers | 30 minutes 5. Research Question | 2 hours
2	1. Intro to Python | 5 hours and 30 minutes		
3	1. Visualizing Data with Pandas | 4 hours 2. Data Drawings | 1 hour 3. Breaking Down Stereotypes of Researchers | 30 minutes	7-10	1. Find Open Data | 3-9 hours 2. Intersectional Data Visualizations | 20 hours 3. Background Research | 15 hours 4. Create Surveys | 1 hour and 30 minutes 5. Send Surveys | 1 hour and 30 minutes 6. Analyze Survey Results | 1 hour and 30 minutes 7. Data Drawings | 45 minutes 8. ArcGIS StoryMap | 45 minutes 9. Present Findings to Stakeholders | 5 hours
4	1. Intersectional Data Analysis of Food Insecurity, Environmental Injustice, and Housing Inaccessibility Part 1 | 5 hours and 30 minutes		
5	1. Intersectional Data Analysis Part 2 | 3 hours and 30 minutes 2. Research Methods Round Robin | 2 hours		

Fig. 1. Data Activism Program Lessons

We conducted 16 hours of interviews with students and community organizers. The interviews underwent transcription using Otter.ai's transcription feature, followed by a meticulous review to ensure accuracy. Also, we utilized thematic analysis to scrutinize the interviews conducted with both students and community organizers.

To ensure data confidentiality, all interview data was securely stored on a cloud accessible only to the principal investigator, senior researchers, undergraduate researchers, and a graduate student. In this research project, ethical considerations were of utmost importance, and written consent and assent were obtained from all participating students, parents, and community organizers prior to data collection. Notably, this project provided monetary incentives to the students and community organizers for their valuable contributions.

III. RESULTS

A. Critical Participatory Action Research Final Project Content

During the last four weeks of the program, 24 high school students collaborated with community organizers on a final project centered around data activism. The goal was to support the community organizations and the people they serve. The students presented their final projects using an ArcGIS StoryMap, which offers interactive engagement with maps and data visualizations through an online website. Data visualizations were generated using Python and the data analysis tool, Pandas. This was done in Deepnote, an interactive data analysis notebook platform. Subsequently, students utilized Canva, a graphic design website, to enhance the accessibility of the visualizations, and ArcGIS StoryMaps to create interactive maps and websites. The students were divided into three groups, each focused on one of the three community organizations: Habitat for Humanity, Food Link, and Charles River Watershed Association. In addition to presenting their research findings, they shared their data drawings, which provided a visual representation of their work, allowing the audience to better understand their findings and conclusions.

1) Habitat for Humanity: The students focused on addressing the racial homeownership gap and delved into its historical context, with a particular emphasis on the impact of redlining in Boston's Roxbury neighborhood. Students utilized data analysis to explore racial disparities and conducted surveys to gather community insights. Additionally, they created a zine to challenge negative stereotypes and promote a positive image of their neighborhoods.

2) Food Link: This research team highlighted the severity of food insecurity, focusing on the demographics of the most affected areas and the historical context of redlining. They also conducted surveys to understand the reasons for food pantry usage. The students concluded that food insecurity is a critical issue and emphasized community awareness and support. They created block print tote bags and t-shirts to raise awareness.

3) Charles River Watershed Association (CRWA): Students conducted research on the impact of flooding in the Dorchester neighborhood of Boston and its disproportionate effects on low-income communities, particularly those with higher African American and Latine populations. The students created data visualizations, including maps that showed areas at risk of flooding and the community assets vulnerable to these floods (Figure 2). They also conducted surveys to gather information on public awareness of flooding and its impact. Lastly, they designed stickers to raise awareness.

B. Pre- and Post- Survey Results

The liberation framework encompasses various aspects, and different questions were employed to evaluate students.

1) Activism Skills: Students were asked to rate their agreement with the statement "I know how to use data science to combat racism" (Figure 3) using a seven-point scale (ranging from one for "Strongly disagree" to seven for "Strongly agree"). Before the class, 6% of students believed
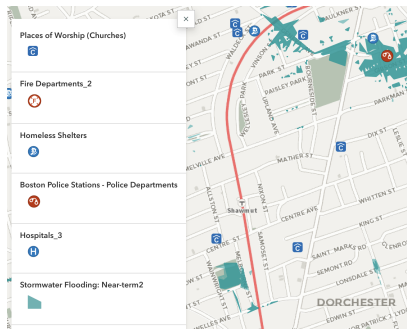
Fig. 2. This ArcGIS map investigates the community assets situated in Boston neighborhoods that are susceptible to stormwater flooding from the 2030s-2050s.

they possessed this knowledge to some extent; however, after the class, 71% expressed the same sentiment. Importantly, no students disagreed with the statement after the class. The Mann-Whitney U test confirmed a significant difference between pre-survey and post-survey responses (p-value = .01, statistic = 72.0), indicating the class effectively taught students how to use data science to combat racism.

2) Liberation Centered Academic Identity (LCAI): - Another question asked students' whether they believe they know how to use their academic success to combat racism (Figure 4) with the answer choices being "False","True", or "Not sure". Before the data activism class, 41% of students felt they knew how to use their academic success for this purpose. After the class, this number increased to 77%. Based on the analysis conducted using the Mann-Whitney U test with the available data, it can be concluded that there is a significant difference in students' understanding of using their academic success to address racism between the pre-survey and post-survey (p-value = .03 and statistic = 90).

3) Critical Consciousness: The next question asked students to rate their agreement with the statement, "Technology can help decrease racism" using a seven point scale. Before the class, 59% of students agreed to some extent that technology can help decrease racism. After the class, this number increased to 77%. While statistical analysis (Mann-Whitney U test) did not provide strong evidence of a significant difference between pre-survey and post-survey responses (p-value = .065, statistic = 93), the slight increase is encouraging.

4) Collective Obligation: One question related to collective obligation, asked students to rate their agreement with the statement "I believe that it is essential that people of color help one another in order to decrease racism" using a seven-point scale. Prior to the class, 94% of students agreed with this statement to some extent. After the class, this percentage decreased to 88%, representing a 6% decrease. Based on the analysis conducted using the Mann-Whitney U test with the available data, it cannot be concluded that there is a significant difference in students' belief in collective action amongst people of color to reduce racism against African Americans between the pre-survey and post- survey (p-value = .9 and

statistic = 141.0).

5) Sound Racial Identity: An additional question prompted students to assess their level of agreement with the statement "I consider my race as a significant aspect of my identity" using a seven-point scale. The pre-survey had 94% agreeing to some extent, while the post-survey had 88%. Based on the results of the Mann-Whitney U test with the provided data, we cannot conclude that there is a significant difference in whether they see their race as an important part of their identity between the pre-survey and post-survey (p-value = 0.50 and statistic = 163.0). The small decline in students perceiving their racial identity as important may be due to the absence of an activity about African American achievements.

C. High School Student Post-Interviews

After the students finished presenting their projects, we conducted individual interviews with them in order to gather more information and insights to answer our research question.

Question 1: How has this project helped you realize that you can make a difference in your community?

This question was designed to investigate the different aspects of the data activism program that encouraged students to bring about change within their community. Out of the 16 respondents, an overwhelming majority (15) conveyed that their involvement in assisting community organizations had substantially elevated their confidence in their capacity to effect positive change within their community in the future. Students were empowered to effect change in their community while working with the community organizers because of their ability to support their neighborhood (5), creation of data visualizations related to community organizations (5), proficiency in conducting background research for community organizations (3), dedication to the community organization's mission (2), and insights gained from survey results about people's concerns (2) (Figure 5). Even among the one student whose confidence did not primarily stem from this collaboration with the community organizations, they acknowledged that the ability to locate and analyze data about important concerns had given them the assurance to continue supporting their community.

The prevalence of students attributing their increased confidence to collaborating with community organizations underscores the importance of such partnerships in data science curricula. One student gained newfound confidence through their ability to support Habitat for Humanity. In their own words,

> Habitat for Humanity didn't have this data, and they couldn't analyze it. Even as a high school student, I was able to do that and bring more awareness to certain issues, making me realize that I could make a change.

This student underscored the pivotal role of their data activism project with Habitat for Humanity in boosting their confidence as a community change-maker.

Furthermore, one student initially expressed fear of presenting to audiences, possibly alluding to their experience
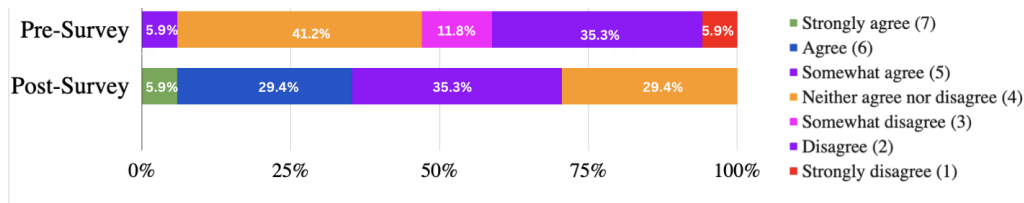
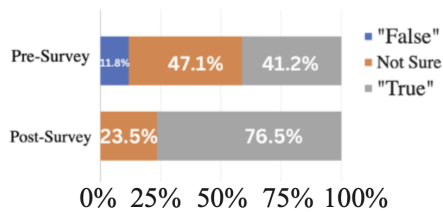Fig. 3. **Survey Insights of Data Activism Program: Activism Skills**

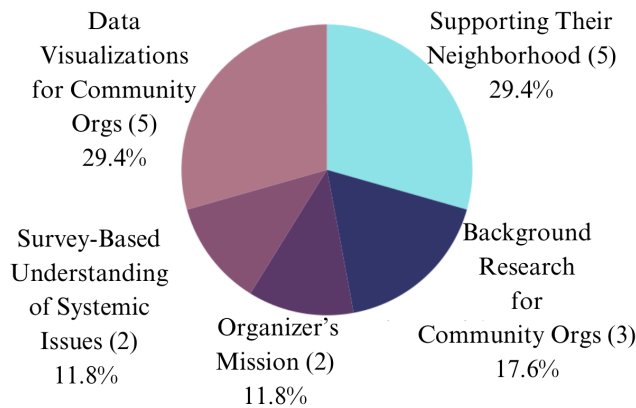Fig. 4. **Survey Insights of Data Activism Program: Liberation Centered Academic Identity**

Fig. 5. **Inspiring Transformations: How Working With Community Organizers Motivated Students to Create Positive Change in Their Community**

presenting their work to community organizations during two research symposiums. This unique experience exposed students to influential individuals such as the Assistant Superintendent of their school district, founders of influential nonprofits, teachers, community organizers, family members, and researchers, reinforcing the idea that people genuinely cared about their efforts.

Another student shared,

> This project helped me realize that I can make a difference because I realized that I wasn't alone, especially when I shared my ideas. The project we were doing with Habitat for Humanity was focused on Roxbury. As a Roxbury resident, I could verify the information, which empowered me to see that I can make a difference because I had a lot of experiential knowledge which was essential to the

completion of the project.

This quote exemplifies a student's belief that their expertise was crucial in a community project, showing the importance of allowing students to engage in projects rooted in their own communities. In summary, the student's collaboration with community organizers fostered a sense of empowerment among students, making them realize they were not alone in their efforts and enabling them to use their skills and experiences to effect meaningful change in their communities.

Question 2: What was your experience with working with community organizers?

All 17 students expressed appreciation for the information and guidance provided by the community organizers. The majority of students noted that their positive experience was due to the expertise and knowledge that the community partners brought to the project. However, three students stated that they would have benefited from more time with community organizers, and one student stated that they wished they could work with more than one community organizer.

Specifically, students mentioned how the community partners were able to provide them with a different perspective and help clarify their ideas. Some students appreciated the interactive nature of the community partners, as it allowed them to work collaboratively. One student stated,

> It was honestly great. I already knew about Habitat for Humanity, but they really explained their goal and mission to me. Even from that, I think it made our project a lot easier because they helped us decide what to focus on. So I think they were really supportive.

Overall, the positive experience that the students had with the community organizers reflects the importance of community partnerships in curricula. It also highlights the valuable knowledge and expertise that community partners can contribute to student-led projects.

D. Community Organizer Post-Interviews

The community organization interviews were conducted to gather insights from four community organizers regarding their experience working with students who participated in the data activism program.

Question 1: What's the possible impact that your project could have on your organization and the people that you are trying to support? Can you give a specific example?

All four community catalysts expressed interest in using the StoryMap websites to bring more resources to their commu-

nity, whether it be by sharing data analysis with government officials, raising awareness of community issues, or making decisions within their own organizations. The StoryMap websites created by the students are essential for supporting community organizations by providing an interactive way for community members and organizers to access this data.

One community organizer who wished to share data with government officials said,

> I will certainly incorporate their StoryMaps into my work, particularly when I engage with different neighborhoods and interact with city councilors, the mayor's office, and city staff. We routinely bring in an array of resources, data, and analyses for various issues, making these StoryMaps a valuable tool for our engagements.

Three of the four community organizers expressed hope that the StoryMaps could help them make decisions within their own organizations. An organizer said,

> We are going to use this project to help us organize and prioritize the outreach that we've been using with our current homeowners. Now we can prioritize our efforts to start planting trees in areas that may need trees the most because of these maps that literally show the number of trees and the amount of green space.

In essence, the organizers found that the students' deep knowledge of their respective neighborhoods and their capacity to apply their data science skills to address systemic issues proved to be immensely valuable for the successful completion of their projects.

Question 2: What was your least favorite aspect of this project?

> All of the community organizers expressed a desire for more time to work with the students on this project. In particular, two organizers wished for a clearer outline of deadlines for different tasks. Their responses show that community members wanted to be more involved in the project and have more opportunities for communication and collaboration with the students. Furthermore, one participant proposed that a more concise survey, consisting of just three questions, which they shared with the community to solicit ideas on various topics, would have been preferable. Essentially, some community organizers found the process of creating the community survey confusing and believed that additional guidance could have enhanced its effectiveness.

IV. DISCUSSION

In the discussion section, the analysis of interviews, students' projects, and surveys from the data activism program are presented to address the research question: "How does the acquisition of liberatory data science skills contribute to students' proficiency in each of the liberatory computing pillars?" The program has had a significant impact on students across several key areas:

1. Sound Racial Identity: Based on the survey findings, the slight decrease in students perceiving their racial identity as significant could potentially be attributed to the absence of an activity focused on African American achievements. Future efforts will include this activity.

2. Critical Consciousness: The program has enhanced students' critical reflection skills, enabling them to identify examples of systemic racism and take critical action through data-driven advocacy. Students have gained confidence in their coding skills and a deeper understanding of systemic challenges faced by African Americans, highlighting data science's potential to combat racism.

3. Liberation Centered Academic Identity (LCAI): The program has cultivated a liberation-centered academic identity among students. The students integrated diverse subjects into their projects, demonstrating interdisciplinary knowledge application. Students are now more aware of using their academic skills to combat racism and are committed to integrating data activism into their lives beyond the program.

4. Collective Obligation: In their final projects, students demonstrated a rejection of societal justifications for the disadvantaged position of African Americans and a commitment to collective action and resource pooling to dismantle racial injustices.

5. Activism Skills: This program has equipped students with crucial activism skills. They have learned how to use data science to mitigate racism and have had tangible real-world impacts through their projects with community organizers. Students have effectively utilized data science, art, background research, and qualitative analysis to raise awareness and create change in their communities.

V. CONCLUSION

The data activism curriculum has effectively readied students for data activism, instilling in them the drive to pursue academic excellence as a means to advance racial liberation and providing them with essential skills to bring about meaningful change in their communities. The inclusion of CPAR in the data activism curriculum, which ensures students collaborate with community organizers, has been demonstrated to increase the number of students interested in applying their data activism skills to support their community further. Future efforts will focus on bolstering students' understanding of their racial identity by incorporating more relevant content. Additionally, extending the program's duration will allow students more time for teamwork and the development of their collective obligation skills. Looking ahead, a comprehensive analysis of all 28 survey questions and 11 interview questions, from both students and community organizers, will be conducted to better inform the curriculum's potential integration into public schools.

VI. ACKNOWLEDGMENTS

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