Educational Programming Practices that Inspires Change: Social Justice as Situated in a Computer Programming Course

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***Abstract*—This paper presents the results of semester-long integration of situating social justice content and contextual topics in a computer science data structures course at a Historically Black College. Computer Science (CS) education practices often include many active learning pedagogies that encourage students to develop internalized constructs of the theoretical underpinnings of programming languages and environments of computing applications with less focus on the applied concepts that personalize new-found skills for students in the classroom [3]. The primary objective of this innovative pedagogical practice focuses on reframing technical concepts in a computer science data structures class. In this work we motivate students to develop programming assignments that are framed as an aspect of a technical solution within the lens of social justice applications in an inquiry-based learning pedagogy. We show that by scaffolding the socio-innovative practices with topical content, students can experience topical-based competencies in the context of addressing real-world problems that can prepare them for problem-solving skills that will follow them beyond graduation.**

Keywords—Social Justice; Computer Science Education; Data Structures; Minority Institutions

I. Introduction

Substantial research in computing education has identified engagement as a valuable indicator of academic achievement. Additionally, considering the ethics and social responsibilities associated with computing infusion in our society has become a topic of interest in many educational communities [3]. Much of this consideration focuses primarily on remitting non-ethical-based practices in computing. Still, very few educators have considered the need to develop scientists who purposefully utilize their skills to create positive social and global impact [7]. The primary objective of this innovative pedagogical practice focuses on reframing technical concepts in a computer science data structures class in order to motivate students by allowing them to develop programming assignments framed as an aspect of a technical solution within the lens of social justice applications in an inquiry-based learning pedagogy.

It is worth noting that many college students spend a good portion of their academic lives situated and sheltered on the school campus. Yet, due to the proliferation of social media and technology-mediated communication practices, university campuses are increasingly becoming more prevalent platforms for protest and engagement in issues of their greater localities and communities. While some campuses may seek suppression of student engagement in social justice-based activities, our work allows productive engagement with campus, local and global issues of concern [12].

Computer Science education practices often include many active learning pedagogies that encourage students to develop internalized constructs of the theoretical underpinnings of programming languages and environments of computing applications with less focus on the applied concepts that personalize new-found skills for students in the classroom [3]. We show that by scaffolding the socio-innovative practices with topical content, students can experience topical-based competencies in the context of addressing real-world problems that can prepare them for problem-solving skills that will follow them beyond graduation.

II. Background and Related Work

Previous work in computing education highlights the value of personally relevant topics and culturally relevant pedagogy in increasing the identity and relationship to computational concepts and computational thinking disseminated through classroom activities and coursework [8, 11].

A. The Spelman] Difference

The work presented in this paper has been situated at Spelman College, a Historically-Black all women's college, data structures course. Spelman is a global leader in educating women of African descent from around the world into trailblazers in their field of work who are also committed to positive social change as illustrated in the school tagline "A Choice to change the world". Critique, engagement, and sometimes protest, are included in themes associated with many non-science courses across the campus landscape [1, 6]. The authors desired to create continuity in our motivation to create change agents within our computing student populations by exposing them to various social justice issues that could be aligned with curricular assessments in the hopes of motivating students to see computing development as a means of creating socio, political and environmental change in their immediate and broader communities.

According to the college, 48% of the student population is PELL grant eligible. Many of these students are from low-

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income and underrepresented backgrounds. With the proliferation of digital media, black youth are becoming increasingly informed and organized about social ills within their communities and environments. The coursework and assignments are given in this course centers the experiences youth face with injustice and promote discourse that will lead to ideation and development of solutions that will promote the Social Justice Youth Development Framework (SYJD)[4] as presented in the results section.

B. Social Justice Defined

The term *social justice* was first coined by a Peruvian priest, Gustavo Gutierrez, as a vocalization of the economic disparity in Latin America[5]. In general, the notion of justice can be defined most concisely as the concept of fairness within society. Within the complex structure of modern societies, justice can be defined in many ways and through various lenses. For this work, we will situate our definition of justice as juxtaposed with Fraser's three-dimensional framework of justice [9]. According to Fraser, justice is founded on a *parity of participation* in which all members of a society can equally be held in moral worth and participate as peers in all aspects of social life. Furthering this idea, we posit that social justice is also related to the notion that each person can equitably access their highest aptitude and contributions toward the society and personal development in their participation and navigation across social strata of the society. Determining the remediation of justice in context is where social justice education begins. Fraser's three-dimensional theory of justice claims that injustice can be rooted in: 1.) (Economic) Distributive injustice - or the lack of resources, 2.) (Cultural) Status inequality or misrepresentation, 3.) (Representation) Political inequality by which the legislative, and structures of decision rules uphold/furnish the stages upon which the first two dimensions play out [9].

C. Social Justice in Computing

CS for All is a recent National Science Foundation (NSF) initiative turned organization that engaged the disparity in access to computer science education in the K-12 community as a means to increase our future technology workforce to include currently marginalized groups. To that end, much of the efforts in social justice in computing education centered on remediation of the disparity in this specific educational domain [4]. Other computing efforts focus on technology development that centers on social justice in human-computer interaction and user experience design [2, 10, 13].

By providing social justice contextualization in the scope of computing education, this work creates a valuable point of intersection of both perspectives. A practical additional intersection of social justice lies in the exploration and research on computer science ethics. While this work does discuss the ethics of societal disparity, there is a less direct focus on ethical concepts as structured in frameworks around ethical principles in computer science education.

III. Methods

A. Participants

16 African-American woman computer science majors in a Spring 2018 CS3 course participated in this research. Students were surveyed early in the semester about their prior knowledge and participation in social justice-related activities. From this initial survey, the list of issues and topics to be covered in the course was curated. In regards to their computing experience with social justice and community issues, only 20% (n=10) of the survey respondents had ever participated in a social justice computing event prior to the course. 40% (n=10) of the students indicated that they had previously developed a technical solution for an issue of concern.

Prior to attending this class, 80% (n=10) of the students had previously discussed social justice issues in a college course. Additionally, 60% have had previous introductions to social justice in a science course in college.

B. Defining Social Justice Projects and Assignments

The social justice-based content activities were administered throughout the entire semester course and lab section as series of videos, interviews, discussions, homework assignments, and labs.

Q1: Is there a social justice issue of importance to you? Have you been involved in activities related to this issue?

Some of the responses were subsets of broader social justice issues. Topics listed include: poverty, HIV/AIDS, food insecurity on college campuses, lack of STEM resources in 'at-risk communities, food studies in rural areas, sexual assault/rape culture, gentrification, and homelessness.

The course topics and mappings to student responses:

- Food insecurity
- Sexual and Reproductive Justice
- Environmental Racism
- Drugs Social/Economic Disparity
- Urban Development
- Any Topic of Choice
-

For homework assignments, the scaffolding occurred alongside the standard homework programming assignment format used in typical programming courses within the department. Previous semester assignments were modified to allow for contextualization across the topics presented in the class.

C. Course Implementation

The semester activities were structured as such:

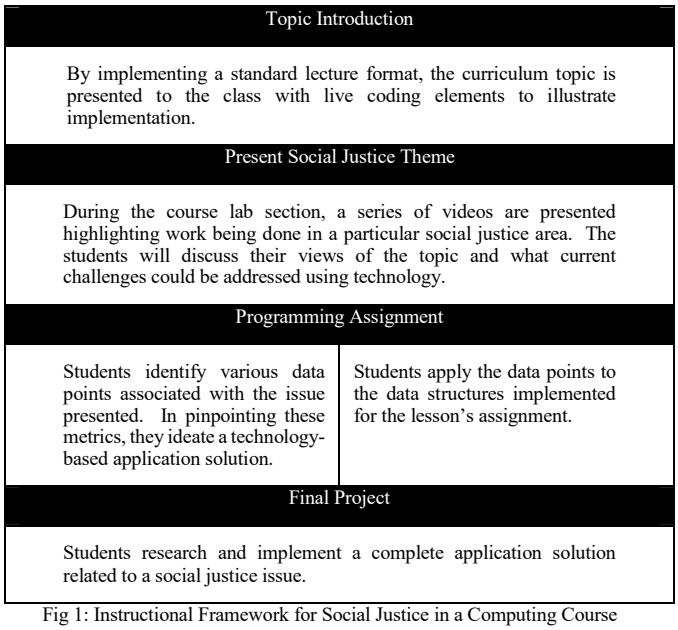

Fig 1: Instructional Framework for Social Justice in a Computing Course

D. Mapping Student Interests to Course Topics

The results of the student interest question were used to choose the social justice topics to be introduced in this semester's course.

TABLE I. CONTENT INTEREST MAPPINGS

Course Topic	Student Responses
Food insecurity	Poverty, Food insecurity on college campuses, Food studies in rural areas
Sexual and Reproductive Justice	Assault/rape culture, Tampon tax, HIV/AIDS
Environmental Racism	Flint water crisis
Drugs in Social/Economic Disparity	HIV/AIDS
Urban Development/Blight	Homelessness, Gentrification
Student Choice	STEM Resources

E. Building Empathy

To connect students to the various social justice topics each week, a variety of media-based resources were collected and shared during the course's lab section. After viewing videos on the topic, the students would engage in roundtable discussions about their personal views on the issue and provide additional insights on their personal experiences with this disparity or injustice.

F. Data and Ideation

After researching a topic, students first considered and detailed associated data points. Students were then prompted to consider their own technology interventions and solutions; they would then share through discussion their thoughts on how technology and data could be used to control, collect or map metrics related to their social justice solution.

While student responses differed, each still aligned to the final homework assignment. An example in the topic of food insecurity from two students:

TABLE II. ALIGNING DATA LITERACY TO IDEATION

Sample Data Points	Technology Intervention
"Data includes: the population of the community, traffic, health of the community, type of food, day intervals, mental health of the community."	"A computer application that I created was a drone that would pick up food and deliver it to the communities. The users would be the grocery store employees where they will navigate the groceries to the different areas. This platform promotes healthy eating and the availability of grocery to communities that do not have that privilege and are stuck eating affordable but unhealthy foods. The problem of lack of available healthy food stores will be solved since the drones are coming to the community. Many people cannot commute to certain grocery stores that do have healthy foods because of the cost of travel."
"What is data? Vendors, Mileage/ Gas prices, Health documents, Population, Childhood obesity/ malnutrition, Free/reduced lunch, Nearby fresh food markets, Zones, Housing Stats."	"A computer application to serve a small fraction of this issue could be designed as a mapping system for the bus route. The platform would sort beginner pilot locations based on immediate need/ disparity with a corresponding formula that ranks each location by necessity. The users are the navigation team as well as the owners of the food truck business deciding on where to go first. The problem of finding the community with the most need is being addressed through this application.

G. Student Assignments

TABLE III. SEMESTER COURSE ASSIGNMENTS IN SOCIAL JUSTICE CONTEXT

Social Justice Topic	Course Content Area	Assignment
Food Insecurity	Inheritance (Python) Attribute Modifications	HW2 -Define a class using inheritance to be used in your technology solution. HW3 - Using the classes that you developed in HW 2, create a menu-driven program that will allow a user to add objects, modify at least one attribute and display a list of attributes. Demonstrate each of these functionalities in your driver.
Sexual and Reproductive Justice	Linked List Implementation (Python)	HW4 - Develop a program using the LList API to create a menu-driven system that will store a list with two data attributes (2 items). Your menu should allow users to use all the methods described in the LList API from the text.
Environmental Justice	Stack Implementation (Python)	HW 5 - Consider that a community activist Russel Honore had been collecting names of those families who were afflicted by health issues related to toxins in the environment in Cancer alley since 2004. When he entered them into his computer program, the names were reversed, and the list now has

		the oldest residents at the bottom and the newest entries at the top. You have been charged by the Bucket Brigade with creating a program using a stack data structure that will read in this list of names line-by-line and reverse them into another document so that
Drugs and Social/Economic Disparity	Class implementation (C++)	HW7 - Develop a C++ class for your solution above that has at least 2-member variables and 4-member functions. Demonstrate the class by writing a program that creates at least three instances of it. Display the object data on the screen.
Urban Development	Operator overloading (C++)	Nneka Nnamdi is developing a mobile application to track blighted properties throughout the city of Baltimore, MD. In this application, she would like to be able to see how long each property has been on the list with no response from the municipal or development agencies. Your role is to design a class called TrackProp. The class's purpose is to store a value that represents a property tracked hours and covert it to a number of days. For example, 8 hours would be converted to 1 day, 12 hours would be converted to 1.5 days, and 18 hours would be converted to 2.25 days. The class should have a constructor that accepts a number of hours, street address, and zip code, as well as member functions for storing and retrieving the hours and days.

IV. Results

A. Student Homework Assignments

It was clear initially that students struggled with the notion of having assignments that were less strictly defined. They were very used to producing programs that should follow an exact output result and format. For many of the assignments in this semester, the student's code would produce vastly different output while satisfying the conditions and usage of the course content. Many of the students indicated that their frustration early in the semester. Some representative responses when prompted:

Q5: What was most challenging about developing these programs in HW2 and HW3?

- "HW2. It was more challenging to think of how to make a technical solution for a social justice issue."
- "Knowing when to make decisions for creating the option to add and create objects upon request. It was a little more time-consuming as well."
- "creating classes, figuring out what certain words mean and what is asked of assignment."
- "It was very challenging because I find that it is hard to freely code. My skills are not refined enough to write code from creativity. A ton of trial and error that I find very challenging. But the better part is that when you know what you are doing you really know."
- "I understood it more during HW 3 but it was really just making the circle class into reality. It challenged me, but I sat down and figured out how to use what I had to make it work. The other part that was challenging was allowing for the user to change information, and if they select to show all information without changing the attribute, it won't work."

In the subsequent prompt, students were asked:

Q6: What did you enjoy about developing this program (HW2 and HW3).

Much of the student responses related to the stimulation of real-world and social application related to their success or enjoyment of the assignment. Some representative responses included:

- "It was like no other coding assignment I have ever done. I appreciate the freedom to create whatever we wanted. Everyone's program is unique and creative."
- "I enjoyed the conversation part about the assignment where we came up with ideas on how to groceries to disadvantaged communities."
- "I enjoyed thinking of ways to use an application to help solve a social issue. I also enjoyed creating different classes that depended on each other and seeing all the information to come together in the driver file."
- "I enjoyed being able to apply the technical knowledge we learn to a real-world issue. That's what I think is missing from the CS curriculum at Spelman real-world application. I am glad this class incorporates some of that into our assignments."
- "It was interesting relating this program to the real-life situation: Food Security. I felt like I was solving a problem already!"

B. Final Projects

Student final group projects allowed them to pick a social justice issue of choice and develop a full application and research paper highlighting an organization working in this area. Some of the students enhanced on a prior homework assignment, while others reached out to groups outside the areas presented in class. Overall, the students were very excited to present their projects in class and one group continued their project development beyond the semester.

V. Conclusion

This paper presented the results of a semester-long computing curricular practice to integrate social justice content with computing principles in CS3 course. The motivation of this project was to create continuity in building a future of change agents among students across disciplines at a historically black women's college.

While students seemed to enjoy engaging these topics from a solution-based perspective, they also seemed to have challenges with the idea of producing assignments that do not produce fully defined output. Early in the semester, students also appeared to have challenges bridging the gap required to choose the appropriate computational methods that would apply to the desired solution, even if the methods were explicitly stated in the assignment prompt.

Toward the end of the semester, the students had less problem navigating these challenges. They were able to use the skills learned in class to construct appropriate solutions and apply computational thinking skills to a variety of technical implementations.

One unexpected outcome of these very important and stimulating topics of conversation during lab sessions was that the class seemed to physically 'lean in' more as the semester progressed. Students would move from behind their devices and return to the more nebulous areas of the class, where the discussion circle would happen during lab. Students would take their laptops and chairs appropriate fluid active learning space by huddling together during labs or joining the professor at the front desk to engage in lectures. It would seem that deep discourse on social justice issues of concern creates an opportunity for groups to explore the humanity of those in discourse. This course flow lends to a flattening of classroom hierarchy that makes culturally relevant pedagogies successful.

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