# WIP: The Appeal of Computing for Social Good to Underrepresented Student Groups

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***Abstract*—This work in progress research paper describes preliminary results of a survey-based study with the goal of answering the research question: Are students in underrepresented race/ethnic groups more interested in and motivated by humanitarian applications of computing rather than non-humanitarian applications? The survey explores student interest and motivation by asking them to choose between humanitarian and non-humanitarian computing applications. The study builds on theories and prior studies that indicate that student learning is improved by providing context to learning in the form of authentic, collaborative engagement with the subject matter. The study also builds on prior research that indicates humanitarian applications may have special appeal to some student groups that are underrepresented in computing education. This prior work includes ad hoc observation by the authors and several small scale surveys that were administered to upper level computing students. Part of the motivation for this study was to see if the same preference for humanitarian applications was apparent with students taking introductory computing courses. Introductory computing students at four institutions completed the survey and the responses of 340 students were analyzed based upon their self-reported races/ethnicities. Students in all race/ethnic groups indicated a higher interest in and motivation by humanitarian applications over non-humanitarian options. In fact, all race/ethnic groups preferred humanitarian over non-humanitarian computing applications at the $p<.001$ level. In considering differences across race/ethnicities, results indicate that humanitarian applications of computing are particularly appealing to Black and Latinx students. In combination these results indicate that all student groups might be better engaged by course materials that provide a humanitarian context, and underrepresented Black and Latinx students might find the humanitarian connection particularly compelling. Based on these findings, instructors might consider framing programming examples and assignments with a humanitarian focus in order to engage students and potentially increase the number of underrepresented students studying computing.**

***Index Terms*—Computing for social good, Diversity in computing, HFOSS**

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## I. Introduction

Computing instructors often look for context and applications that will interest students and motivate them. For over a decade, a community of faculty have used humanitarian open source projects in education and found some evidence that the humanitarian element is particularly motivating to women and other traditionally underrepresented groups of students [1], [8], [16], [17], [26], [35]. The prior work looked at students taking upper-level computing courses where students contributed to humanitarian open source projects. Unfortunately, the impact on traditionally underrepresented groups is difficult to measure statistically as these courses had a small number students from these groups.

In order to look specifically at interest in and motivation of humanitarian aspects of computing across gender and race/ethnic groups, this study looked at introductory classes which have a greater enrollment and diversity than the upper-level courses previously studied. Previously reported results of this study indicated that women prefer humanitarian applications over non-humanitarian [27]. This paper addresses the research question: Are students in underrepresented race/ethnic groups more interested in and motivated by humanitarian applications of computing rather than non-humanitarian applications?

## II. Background

Despite recent efforts to improve the participation of underrepresented groups in computing, the number of these students in computing degree programs has not shown substantial increase in the past 10 years [25], [36]. There are multiple ongoing efforts to address this issue using a variety of approaches including increasing the feeling of inclusion [19], [22], application of social theories [7], [31], the use of projects and other collaborative learning experiences [1], [4], and efforts at the institutional [24] and state levels [29].

In this paper, we examine the possible role of interest in humanitarian applications to increase participation of underrepresented groups in computing. Interest is critical to academic success as it stimulates students to engage in thinking about a topic, to understand and organize the problems related to the topic and to persist when solving these problems. This persistence eases the feeling of effort required to solve

problems and increases the possibility of successful problem solution [30]. Interest in a topic or area also helps to sustain engagement with that topic, motivating academic success [14]. Stimulating interest holds the potential to increase persistence of underrepresented students in computing.

Interest is a mode of paying attention and a response or feeling towards a situation or object. Interest has long been known as a motivational variable and is defined as "the state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time" [15] p. 112. Interest in a topic is not inherent (e.g., I'm just good at math) nor static, and may be developed or refined over time. For instance, the home environment is known for providing a foundation in engaging with learning various topics such as music and science [30].

Interest encompasses two experiences; the experience of being engaged or engrossed in an object or topic in a particular moment, known as situational interest, and the desire to re-engage with the object or topic over time, known as individual interest [33]. Hidi and Renninger [15] present a 4-phase model of interest development where situational interest has an initial phase in which interest is triggered and a subsequent maintenance phase which involves extended focus on a topic over time. The individual interest phase also has two phases, the emerging individual interest phase which includes a student's positive feelings and, when given a choice, the willingness to re-engage with a topic. The second phase, the well-developed individual interest phase, refers to a disposition to continue to engage with an area of content over time.

Several studies have indicated that student engagement in course content is key to broadening participation in computing [6], [18], [21], [32]. There is also evidence that the humanitarian nature of projects may influence project selection and learning in upper level courses [3], [8], [11], [28]. In this paper, we focus on 4 race/ethnic groups and investigate whether students enrolled in early computing classes select humanitarian software applications more often than non-humanitarian and rate them more highly. Based upon student interest and motivation the authors hypothesize that humanitarian applications might help attract members of underrepresented groups to computing.

## III. Methods

This section describes prior work by the authors and its impact on the current study. The section also discusses the survey construction and the data collection approach.

### A. Prior Work

A pilot survey was conducted by the authors of this paper [9] in order to determine the impact of computing domains on student interest in studying computing. Participants were primarily first year students and results indicated that women were more likely to indicate interest in humanitarian applications than men were. A review of these survey results concluded that the technologies implied by the survey choices might be a confounding factor. This raised the question of whether students were selecting survey options based on the application domain or based on the technologies that could be used to implement the application. As a result, the survey was revised to make the implied technologies consistent across applications to allow the instrument to focus more clearly on student interest in and motivation to develop humanitarian applications, without regard to the technologies used.

In the pilot survey, students were presented with 20 possible applications and picked the top three they would be most interested in developing. The survey used in the study reported here revised these selections into two sections; one related to student interest and a second related to student motivation. For both parts, students were presented with pairs of applications where one choice was humanitarian in nature (e.g., track seasonal flu patients by location) and one was non-humanitarian (e.g., track pizza deliveries by location). The pairs were applications that could be implemented using the same technologies with the goal of eliminating technology as a confounding factor. For this study, humanitarian applications are defined as ones that address societal needs, also referred to as computing for social good applications. The United Nations Sustainable Development goals provide a typical reference set of humanitarian topics [34].

### B. Instrument

This section describes two parts of the survey used to elicit student interest and motivation for various application domains.

Part 1 of the survey focused on student interest and asked **Would You Rather** questions. There were six questions in this part of the survey, and these are referred to in this paper as **Interest** questions. Each question provided two options for a specific application. Students were asked to select between an option with a humanitarian focus and the option with the non-humanitarian focus. For example:

If you were writing an app to ensure data security, would you rather write it to protect:

- Bank accounts of high profile clients
- Medical records of people with mental health issues

Part 2 of the survey focused on student motivation using **Motivation to Learn Programming** questions, which are referred to as **Motivation** questions in this paper. This section contained questions about eight different applications and students were asked to rate their motivation to work on these applications based on a 5-point Likert scale: Not at all (1), A little (2), A moderate amount (3), Quite a bit (4), Extremely (5). Humanitarian applications included collecting data on human trafficking, and non-humanitarian applications included writing an eCommerce application.

The application examples provided in both Part 1 and Part 2 were selected based upon the areas of interest from the pilot survey with additional areas added based upon recent news items and areas of potential interest to college students. The pilot survey used a list of student interest choices shared by the Lighthouse CC Online Course for community college computing faculty, an NSF funded diversity-focused professional

TABLE I
SURVEY PARTICIPANTS BY AGE

| Participant Age | Frequency | Percent |
|---|---|---|
| <18 | 7 | 1.9 |
| 18-20 | 233 | 62.0 |
| 21-23 | 76 | 20.2 |
| 24+ | 60 | 16.0 |
| **Total** | **376** | **100.0** |

development course [23] as the basis for the list of student interests. The options were chosen based upon discussions with a social scientist and spanned a range of areas. The order of the questions for both Part 1 and Part 2 were randomized as were the two choices for the Part 1 questions.

As with the questions in Part 1, options in Part 2 were designed with a clear difference between applications with a business focus and those with a humanitarian focus.

### C. Data Collection

The study involved four academic institutions: a community college, a small liberal arts college, a private university, and a public state university. IRB approval was obtained from all four institutions before the study was started, and study participants were elicited from students in undergraduate introductory computing courses that included some programming across all four institutions. Students were typically in the first or second year of their undergraduate studies and included both computing and non-computing majors. Survey participation was voluntary, and students were told that the purpose of the survey was to better understand the opinions of introductory students about computing. 376 students participated in the survey, resulting in 340 responses usable for this analysis.

## IV. DATA ANALYSIS

Table I summarizes the ages of the 376 participants. The students under 18 were removed prior to analysis as the IRB approval did not allow for participants under the age of 18.

369 respondents answered the race/ethnicity question. Of these, only four groups, totaling 340 respondents, were of sufficient size to support further analysis: Asian, Black or African American, Latinx or Hispanic, and White. Table 2 shows the breakdown of race/ethnicity of the survey participants. The items in bold are used in the analysis.

Throughout the rest of the paper the participants who identified as Black or African American will be referred to as Black and those who identified as Latinx or Hispanic will be referred to as Latinx. When reporting the effect size of the Cohen's d the following abbreviations are used: S (small), SM (small to medium), M (medium), ML (medium to large), L (large).

### A. Overview

Across all respondents, humanitarian options were chosen more often and rated higher overall than non-humanitarian options. For the **Interest** questions, students chose an average of 4.13 humanitarian options out of 6. For the **Motivation** questions, a one-tailed, paired t-test indicated that students were more motivated by humanitarian options than non-humanitarian options $t(358) = 15.42$, $p<.001$. This provides a larger-scale confirmation of the findings of the small sample size surveys and anecdotal information from upper level courses. It also confirms that the overall preference seen with upper level students is consistent for students in early computing courses.

TABLE II
SURVEY PARTICIPANTS BY GENDER AND RACE/ETHNICITY W (WOMAN), M (MAN), NB (NON-BINARY), ND (DID NOT DISCLOSE/SELF-DESCRIBED) AND TOT (TOTALS)

| Race/Ethnicity | W | M | NB | ND | Tot |
|---|---|---|---|---|---|
| American Indian/Alaska Native | 0 | 3 | 0 | 0 | 3 |
| **Asian** | **16** | **48** | 0 | 0 | 46 |
| **Black/African American** | **10** | **34** | 2 | 0 | 46 |
| **Latinx/Hispanic** | **15** | **30** | 1 | 1 | 47 |
| **White** | **56** | **121** | 4 | 2 | 183 |
| 2 Races/Ethnicities | 2 | 1 | 0 | 0 | 3 |
| 3 Races/Ethnicities | 0 | 4 | 0 | 0 | 4 |
| Other | 3 | 5 | 0 | 0 | 8 |
| Did not disclose | 1 | 8 | 0 | 2 | 11 |
| **Totals** | **103** | **254** | **7** | **5** | **369** |

### B. Interest

This study has enough respondents to examine the humanitarian preference by race/ethnic group. This analysis of the **Interest** questions based upon race/ethnic group showed students from all groups chose the humanitarian option more than the non-humanitarian option, indicating their interest in the social good aspect of computing (see Figure 1).

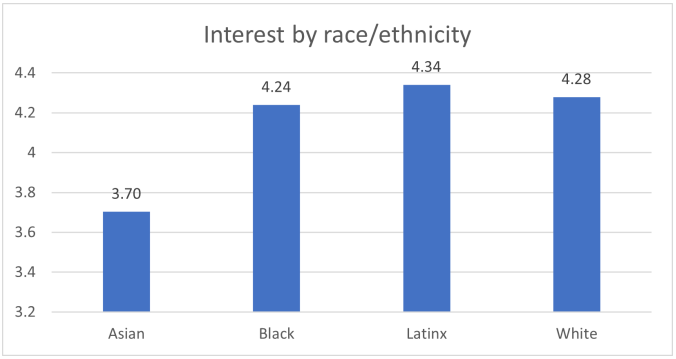


Fig. 1. Average number of interest questions (max of 6) chosen by students that are humanitarian in nature by race/ethnicity.

### C. Motivation

When looking at the **Motivation** questions, all race/ethnic groups rated the humanitarian options significantly higher than the non-humanitarian options (Figure 2) at the $p<.001$ level based upon one-tailed, paired t-tests (Table III). Students in all groups rated the humanitarian options as being more motivating than the non-humanitarian. The average ratings on the humanitarian options were close across all four groups. The largest differentials between the humanitarian and non-humanitarian ratings were in the Latinx (1.08) and White

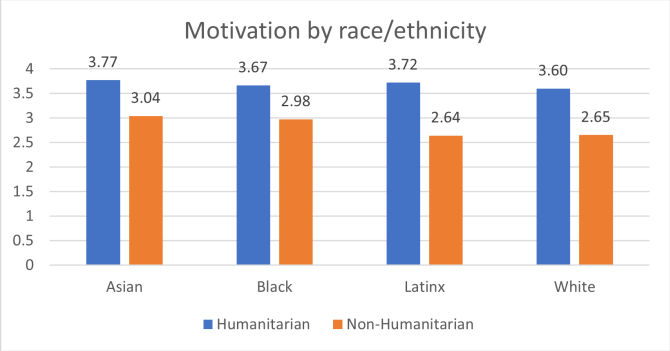


Fig. 2. Average ratings on the humanitarian vs the non-humanitarian motivation questions.

TABLE III
ONE-TAILED, PAIRED T-TESTS AND COHEN'S D SCORES DEMONSTRATING HUMANITARIAN OPTIONS WERE RATED HIGHER THAN THE NON-HUMANITARIAN OPTIONS FOR THE MOTIVATION QUESTIONS.

| Race/ Ethnicity | T-test | Cohen's d | Effect Size |
|---|---|---|---|
| Asian | t(64)=7.13, p<.001 | 0.8653 | L |
| Black | t(44)=4.24, p<.001 | 0.6972 | ML |
| Latinx | t(45)=7.76, p<.001 | 1.1806 | L |
| White | t(176)=11.81, p<.001 | 1.0536 | L |

(0.95) groups whereas the Asian (0.73) and Black (0.69) ratings were closer. The Cohen's d indicated a large effect size for the Asian, Latinx and White groups and a medium to large effect size for the Black group.

## V. Discussion

The results above demonstrate that students in all race/ethnic groups prefer humanitarian computing examples in their courses. Interestingly though, there is some variation in the level of preference for specific options across the humanitarian domain. The survey was designed to provide questions about humanitarian applications in a variety of domain areas including health care, natural disasters, education, homelessness, driver safety, wildlife preservation and human trafficking. The data revealed that not all humanitarian options held equal appeal. For example, in the **Motivation** question analysis, Asian participants rated all humanitarian applications roughly the same whereas Black and Latinx participants rated all but the identifying dangerous traffic intersections roughly the same and White participants rated both the shelters for homeless and traffic intersections lowest. The fantasy sports and chess applications, both non-humanitarian, received low ratings across all races/ethnicities. It is somewhat concerning that chess and sports were ranked poorly as examples because these are often used in computing courses and may inadvertently turn students away from computing. It is also an indicator that instructors might want to include a mix of humanitarian topics to ensure appeal of application examples to a broad range of students.

Choosing application areas that demonstrate the ability of computing to help others may be useful in engaging students from all race/ethnic groups. Making the social impacts of computing visible can be as simple as re-framing existing assignments with a humanitarian focus [10], [12], [13], [20], [28] or as comprehensive as having students contribute to a humanitarian open source project [3], [8], [9], [16], [17], [26], [35]. Providing introductory computing students with projects that address societal issues, such as refugees, homeless shelters, food insecurity, or disaster management allows students to see how learning computing can help their communities. Incorporating humanitarian open source projects into software engineering or capstone courses allows students to gain first-hand experience with having a positive impact on others. Contributing to projects that help people on their campus, their local communities or globally may encourage traditionally underrepresented populations to persist in computing because they see how their skills will directly help others.

## VI. Conclusion

This study looked at whether exposure to humanitarian computing applications might increase interest and motivation of students for studying computing. The preliminary results presented in this paper demonstrate that students from each race/ethnic group studied are both interested in and motivated by humanitarian applications of computing. Two significantly underrepresented groups, Black and Latinx, show very strong preference for humanitarian applications. For all groups, the preference for humanitarian applications is statistically significant.

This study builds on prior work that found evidence that humanitarian computing was generally appealing to students. The prior work was anecdotal or involved small sample sizes and participants were students in advanced computing courses. This study surveyed preferences of students in early computing courses, and obtained sufficient sample sizes to allow examination of the appeal of humanitarian computing by racial/ethnic grouping in addition to looking at the sample as a whole. This analysis by group is essential to ensure that humanitarian computing appeals to all groups of students and therefore will help to build a more inclusive community of computing professionals.

Instructors should note that study results indicate that incorporating humanitarian examples and assignments in early computing courses is motivating for students across all races/ethnicities and particularly for Black and Latinx students, and this motivation may encourage these students to pursue a degree in computing.

Additional studies could be conducted with a larger sample to examine preferences of students identifying as multiple races/ ethnicities. Additional studies could also focus on which humanitarian application domains are of most interest to students and to analyze differences across groups. This would help instructors design assignments that would engage all students.

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