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# Attitudes Towards Computing Amongst Incarcerated Adult Students in CS1

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## Abstract

Recent work has shown that incarcerated adult students reported a decrease in confidence in their ability to do well in the course as the course progressed, whereas non-incarcerated students in a traditional educational setting reported an increase in confidence over time on the same measure. Given these differences in student experiences between incarcerated adult students and traditional students, this work seeks to further understand the experiences of incarcerated adult in CS1, with a focus on their attitudes towards computing. Specifically, we used the Computing Attitude Survey (CAS) as a pre/post measurement in a CS1 course taught in prison. We found significant positive shifts for Problem Solving – Transfer and Fixed Mindset factors and a slight decrease for Real-World Connections. We additionally compare the results of the CAS survey between the incarcerated adult students in this study and those of non-incarcerated students reported in prior work.

## CCS Concepts

• **Social and professional topics → Computing education**; **Adult education**; **CS1**.

## Keywords

Adult Learners, Prison Education, Computing Attitudes, CAS, CS1

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## 1 Introduction

Student attitudes towards computing, and especially how they change during introductory programming courses, is receiving increased attention in computing education research [21]. The development of validated instruments to measure computing attitudes, including the Computing Attitudes Survey [12] used in this study, have increased the ability to rigorously compare attitudes before and after an intervention, and between groups of students [22].

At the same time, there has been increased interest in computing courses in Higher Education in Prison (HEP) programs due to the restoration of Pell eligibility to incarcerated students [17]. HEP programs provide education and dignity to incarcerated adult (IA) students while simultaneously having the potential to better society through reduced recidivism rates. Given the unique educational context and student body in HEP programs, additional research is needed to understand the experience of IA students.

As such, recent works have explored both informal (e.g., coding workshops) and formal (e.g., CS1 for credit toward a higher education degree) CS education in prison and jail settings [16, 28]. However, it is unknown how the unique relationship between incarcerated students and technology, such as restricted access to modern devices, the internet, and software, may impact students' attitudes towards computing [5, 20, 32, 33]. With the global incarcerated population at an all-time high, disproportionately impacting people from otherwise marginalized groups, participation in the growing infrastructure and support for prison education from the CS education community is of critical importance to ensure equitable access to all students [17]. Expanding on foundational work in this space reporting current barriers and emerging strategies for offering CS1 in higher education in prison (HEP) programs, this work establishes an initial baseline of shifts in computing attitudes among incarcerated adult (IA) students in CS1. We aim to answer the following research questions:

(1) How do incarcerated adult students' attitudes towards computing shift after a CS1 course?
(2) How do incarcerated adult students' attitudes towards computing compare to those of non-incarcerated students?

## 2 Background

### 2.1 CS Education in Prison

Prior work on CS education in prison dates back to a 1990 SIGCSE experience report on the challenges and opportunities involved in offering a computer science Bachelor's degree in prison [4]. Additional work in this area has only recently gained momentum, in part due to legislative interventions expanding access to higher education in prisons to combat the global crisis of increasing incarcerated populations [11, 17]. The broader HEP community is increasingly highlighting access to STEM opportunities as a focus, as well as access to adequate educational technology infrastructure [1, 5, 20, 24, 25, 33]. Recent works by Hogan et al. have documented current barriers and strategies for offering CS1 in a higher education in prison program [15, 16]. Other works have documented the experiences of incarcerated and formerly incarcerated individuals in computing workshops and "coding bootcamp" programs [8, 14, 28]. Notably, in a thematic analysis of open-ended survey responses from 34 incarcerated participants in a six-week web design course conducted in five prisons and jails in the U.S., Nisser et al. reported a "predominantly positive impact" on self-efficacy, and some instances where this was not the case. Quantitative results from pre- and post-surveys in this study measuring general and computer programming self-efficacy were not statistically significant [28].

### 2.2 Experiences of Adult Learners in CS

Several prior works have found positive shifts in computing attitudes among adult learners through participating in computing workshops and brief learning experiences. One qualitative sentiment analysis of 200 adult learners' attitudes towards computer programming found that adults initially reported negative attitudes toward programming, "believing that it was difficult, boring, and something they generally could not learn" [9]. However, a brief learning experience had a profound impact, showing statistically significant positive shifts regardless of factors such as gender, population density, and level of education [9]. Another study of adult professional women with no prior CS experience in a nine-week web development workshop "directed at enhancing CS attitudes and skills" found statistically significant positive shifts in coding self-efficacy [29]. However, few prior works have focused on long-term CS education interventions for this population [2, 29]. A literature review on adult learners in CS specifically noted the lack of prior works in CS education drawing on existing literature outside of CS on adult learners, such as andragogy theory [2, 10, 30], and self-determination theory of adult learners[31].

### 2.3 CS Attitudes and Engagement in CS1

The validated Computing Attitudes Survey (CAS) instrument has been used in a variety of settings, including to compare differences in attitudes towards CS among groups historically underrepresented in CS [12]. Prior work found that women in CS1 experienced both a statistically significant larger increase in positive attitudes towards CS, as well as significantly lower initial positive attitudes [12]. Joyner et al. later studied attitudinal trajectories in an online CS1 course at a large university in the U.S. by conducting the CAS four times throughout the course, and found that students who "self-identified as coming from a racial or ethnic minority group" reported no overall change in attitudes, including in an experimental intervention presenting diverse role models in CS, whereas other groups of students –including women– all showed a positive shift in attitudes [19]. Measuring and designing interventions aimed at improving attitudes towards computing has significance in the CS education field, as part of holistically defined student engagement [21, 27].

## 3 Methods

### 3.1 Study Population

The incarcerated adult students in this study were imprisoned in a medium-high security male prison in the United States. Students self-reported demographic information on the first reflection assignment, including age and racial identity. All 20 students in the course responded to these questions, 30% identifying as Chicanx of Latinx, 30% as White or Caucasian, 30% as African American or Black, 15% as American Indian or Alaska Native, 5% Asian or Asian American, and 20% Other (the sum of the percentages exceeds 100 because students could select all that applied). In addition, all students were over the age of 30, with 15% between the ages of 30-39, 45% between 40-49, 25% between 50-59, and 15% 60 or older.

### 3.2 Course Context

This study took place in a traditional college-level CS1 course taught in Python, offered in prison. The first author was the instructor of the course, and had introductory programming teaching experience both in and outside of prison prior to this course. Students had limited access to resources: individual laptops distributed to students for educational purposes had restricted internet access which only allowed them to access Canvas, and the ability to run code of any kind was disallowed by the prison. Several strategies were employed by the instructor to mitigate these barriers, including several recommended in prior work by Hogan et al. such as a common errors resource and providing supplemental videos and reading materials. In addition, students could submit any amount of code once per day via Canvas, and the course staff would run the code and return the output to them with comments on next steps.

The students were all part of the second cohort of students accepted as transfer students into a large research university to pursue their Bachelor's degree after completing their Associate's degree through a community college offering courses at the prison. The first cohort of students in this program also took the same introductory course taught by the same instructor exactly one year prior, but are not included in this study as the CAS questions were not distributed in the first offering. Students' incarceration status was not a factor in the transfer application process to be accepted into this program, and therefore all had maintained sufficiently high grades during their Associate's degree studies. Once accepted into the Bachelor's degree program, students had little choice of degree path or course flexibility, as is common in HEP programs where space constraints and instructor availability restrict the number of different courses that can be offered at the prison [7]. Thus, all of the students were enrolled in the CS1 course discussed in this paper, which fulfilled a technology requirement towards their degree in Sociology, with little to no flexibility in opting out, withdrawing, or failing. Conversely, students also had no choice of pursuing more computing education or a degree in CS through the university after completing the course, granted they remained incarcerated (students who are released from prison can continue their studies on the main campus, where they are free to choose courses and other degree paths).

## 3.3 Data Collection

We measured students' attitudes towards computing at two points during the course using the validated Computing Attitudes Survey (CAS) instrument as part of regular reflection assignments. Students were given handwritten Weekly Reflection assignments every week of the course with a variety of open-ended, short answer, and multiple-choice questions for purposes of course improvement. Reflections were graded for completion, and were worth a small percentage of the total grade. After the course was completed, handwritten reflections were transcribed by the research team and all identifiable information was removed by a third party in accordance with our research protocol (#806658), which was classified by our Institutional Review Board as not human subjects research.

The CAS, comprised of 26 Likert-scale questions, was included at the end of the printed Weekly Reflection assignment in both the first week and the last week of the course. The CAS includes one filter question, appearing 19th out of the 26 questions: *"We use this statement to discard the surveys of people who are not reading the questions. Please select 'Agree' for this question to preserve your answers."* Of the 20 students in the course, 11 students both a) completed the CAS at both the beginning and end of the course and b) answered the filter question correctly on both submissions.

The other 25 questions are associated with five different factors related to computing attitudes, determined in prior work validating the instrument using factor analysis [12], described briefly below:

(1) **Problem Solving – Transfer:** Being able to recognize and/or apply connections between concepts and ideas
(2) **Problem Solving – Strategies:** Using discipline-specific problem solving strategies, such as planning before beginning to write code
(3) **Problem Solving – Fixed Mindset:** Conveying a "fixed" or "defeatist mentality" about the computing discipline, and one's ability to solve problems within it
(4) **Real-World Connections:** Seeing the relationship between computer science and one's lived reality
(5) **Personal Interest:** Statements related to personal interest, motivation, engagement, and enjoyment of computer science

One of the questions is associated with two of the above factors, and the other 24 questions are each associated with one factor above.

## 3.4 Analysis Methods

To answer our first research question, we calculated descriptive statistics for the 11 students who submitted valid pre- and post-surveys. This included the percentage of students who agreed with experts for each individual question, and the median and mean percentage agreement with experts overall, and by factor. We additionally used the Wilcoxon Signed Rank non-parametric test to determine whether there was a significant change in agreement with experts among these 11 IA students overall and for each factor.

To address our second research question, we compared our students' CAS results for median and mean percentage agreement with experts to the baseline reported in prior work validating the instrument for non-incarcerated students on traditional college campuses [12]. The baseline from the prior study was computed using data from two North American universities – one a large research-intensive university, and one a medium-sized institution – in five different introductory CS courses over three semesters. Two of the courses were explicitly oriented towards non-CS majors. This included paired pre-post data for 794 students across these five courses, excluding students who answered the filter question incorrectly or who did not submit both the pre- and post-surveys (47.8% of the 1662 students who submitted the pre-survey with the filter question answered correctly). Our data reflects a similar rate of students with valid paired data (55% of the 20 students). The students in the baseline group completed a prior version (CASv3) of the CAS survey which included all 26 questions on the CASv4 completed by our students, in addition to 27 others which were eliminated in the later version. Similar to our students, whose reflection assignments included other questions prior to the CAS questions, the baseline group completed additional demographic questions at the beginning of their survey.

## 3.5 Applying Critical Quantitative Theory

The research team employed elements of Critical Quantitative Theory in the design and execution of this project, following recent recommendations for greater use and acceptance of critical theory to confront inequity barriers in CS education research [18]. This began with assembling a research team that represented diverse identities and lived experiences, and dedicated group discussion about how our positionalities impacted our research perspective. We embraced the tenet of centrality of oppression through continuous discussion of how systemic racism is deeply embedded within criminal justice and educational structures [13]. In our analysis process of student course data, we reflected on how disparities are not merely statistical anomalies and dedicated discussion to socio-cultural contexts influencing these outcomes. Finally, in our writing of this paper, we emphasize the non-neutrality of numbers and the importance of contextual understanding [6].

# 4 Results

## 4.1 RQ1: IA Student Computing Attitudes

Overall, students reported an increase in agreement with experts on the CAS, from a median percentage agreement of 63.6% on the pre-survey to 72.7% on the post-survey. However, the change was not statistically significant ($p = 0.066$). Figure 1 shows the change in agreement with experts for each CAS question, grouped by factor. For example, Question #1, in the Problem Solving - Transfer category, had 3 of 11 students agree with the experts in the pre-survey and 9 in the post. In addition, our statistical analyses in Table 2 shows the results of Wilcoxon Signed Rank Tests on shifting agreement with experts overall, as well as for each of the five factors.

*4.1.1 Problem Solving - Transfer.* Students reported a statistically significant increase in agreement ($p = 0.031$) on statements relating to problem solving transfer, from a median 31.8% to 63.6%, as shown

| | | Median % Agree | | Mean % Agree | | |
|---|---|---|---|---|---|---|
| | Pop. | Pre | Post | Pre | Post | Shift |
| Overall | IA | 63.6% | 72.7% | 60.7% | 73.5% | 12.7% |
| | Base | 52.0% | 68.0% | 53.2% | 64.8% | 11.6% |
| RW Conn. | IA | 77.3% | 68.2% | 65.9% | 63.6% | -2.3% |
| | Base | 75.0% | 75.0% | 62.3% | 65.5% | 3.2% |
| PS-Trans. | IA | 31.8% | 63.6% | 38.6% | 63.6% | 25.0% |
| | Base | 50.0% | 50.0% | 40.3% | 49.5% | 9.2% |
| PS-Fix. MS | IA | 81.8% | 86.4% | 72.7% | 83.0% | 10.2% |
| | Base | 62.5% | 75.0% | 56.0% | 67.6% | 11.6% |
| Pers. Int. | IA | 63.6% | 72.7% | 59.1% | 75.8% | 16.7% |
| | Base | 50.0% | 75.0% | 53.8% | 66.3% | 12.5% |
| PS-Strat. | IA | 63.6% | 72.7% | 61.4% | 68.2% | 6.8% |
| | Base | 50.0% | 83.3% | 53.3% | 69.8% | 16.5% |

**Table 1: Comparison of CAS pre- and post-survey results for IA students and baseline (Base) from prior work [12]**

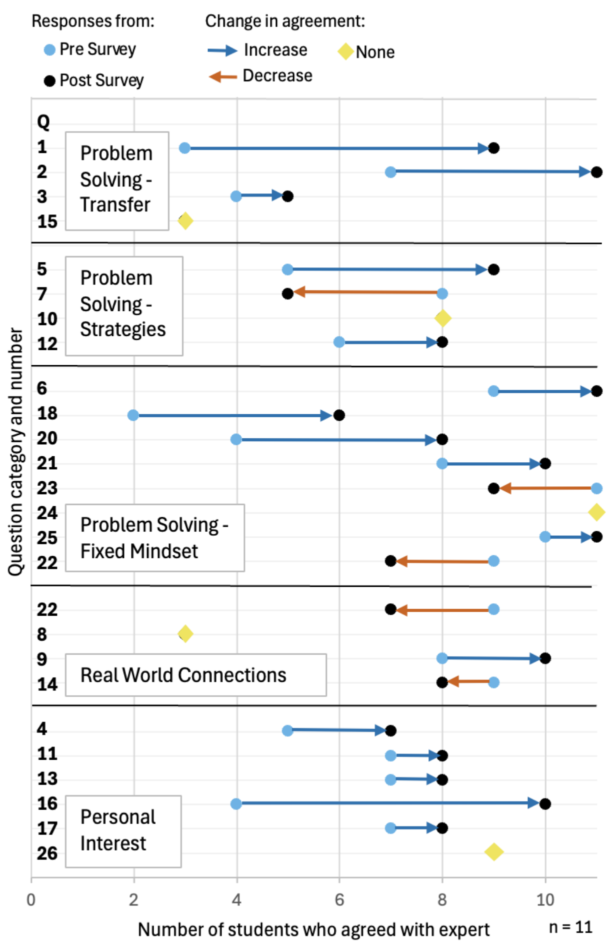


**Figure 1: Change in agreement with experts on each CAS question, grouped by factor**

| | | Med. % Agree | | Wilcoxon | |
|---|---|---|---|---|---|
| | # Items | Pre | Post | Z | p(2-tail) |
| Overall | 25 | 63.6% | 72.7% | 9.5 | 0.066 |
| Real-World Conn. | 4 | 77.3% | 68.2% | 4.5 | 0.854 |
| PS- Transfer | 4 | 31.8% | 63.6% | 3.0 | 0.031 |
| PS- Fixed Mindset | 8 | 81.8% | 86.4% | 2.5 | 0.047 |
| Personal Interest | 4 | 63.6% | 72.7% | 10.5 | 0.142 |
| PS- Strategies | 6 | 63.6% | 72.7% | 18.0 | 0.587 |

**Table 2: Shifts in attitudes reported by IA students**

in Table 2. This factor had the lowest initial median percentage of agreement by a significant margin compared to other factors, and remained the factor with the lowest median percentage of agreement in the post-survey. Of the four questions included in this factor, three had an average increase in expert agreement and one, #15, stayed the same at a low expert agreement, with only three students disagreeing at the start and end with the statement "Learning computer science is just about learning how to program in different languages." The greatest increase was #1, from three to nine students disagreeing with the statement "After I study a topic in computer science and feel that I understand it, I have difficulty solving problems on the same topic."

*4.1.2 Problem Solving - Strategies.* An increase from 63.6% to 72.7% median agreement with experts was reported by students on statements relating to problem solving strategies, but the increase was not statistically significant (p = 0.587). There was a mix of increase and decreases in agreement across the four questions in this factor, with #10 staying the same at eight of eleven students agreeing with the statement: "When working on a computer science problem I find it useful to brainstorm about solution strategies before writing code." The only question decreasing in agreement was #7, from eight to five students agreeing with "There are times I solve a computer science problem more than one way to help my understanding." The largest increase in agreement in this factor was from five to nine students agreeing with the statement: "When I solve a computer science problem, I break it into smaller parts and solve them one at a time."

*4.1.3 Problem Solving - Fixed Mindset.* Students also reported a statistically significant increase in agreement on questions in the Problem Solving – Fixed Mindset factor (p = 0.047), from 81.8% to 86.4% median agreement. Of the eight questions in this factor, five questions increased in agreement, two decreased, and one question, #24, stayed the same with all eleven students disagreeing with the statement: "To learn computer science, I only need to memorize solutions to sample problems." Tied for the largest increase in agreement for this factor, an increase from two to six students disagreed with #18, "A significant problem in learning computer science is being able to memorize all the information I need to know," and from four to eight students disagreed with #20, "Understanding computer science basically means being able to recall something you've read or been shown." Disagreement with #23, "There is usually only one correct approach to solving a computer science problem," decreased from eleven to nine students, and the other decrease was for #22 which is also included in the Real-World Connections factor.

#### 4.1.4 Real World Connections.

The only factor for which students reported a decrease in agreement was Real-World Connections, from 77.3% to 68.2% median agreement. The decrease was not statistically significant (p = 0.854). Of the four questions in the factor, two questions decreased, one increased, and one stayed the same with three students agreeing with the statement in #8: “I think about the computer science I experience in everyday life.” The largest decrease was #22, from nine to seven students disagreeing with the statement: “The subject of computer science has little relation to what I experience in the real world.” However, students increased from eight to ten in agreement with #9: “Tools and techniques from computer science can be useful in the study of other disciplines (e.g., biology, art, business).”

#### 4.1.5 Personal Interest.

For questions relating to Personal Interest, students reported an increase from 63.6% to 72.7% median agreement with experts. The increase was not statistically significant (p = 0.142). Of the six questions, five questions had an increase and one stayed the same with nine students agreeing with #26: “I am interested in learning more about computer science.” The statement in #16 was tied for the largest increase in agreement among questions from all factors, from four to ten students agreeing with the statement “When I am working on a computer science program, I try to decide what reasonable output values would be.”

### 4.2 RQ2: Comparing Computing Attitudes of Incarcerated vs. Non-Incarcerated Students

Overall, IA students began with more positive attitudes towards CS than the baseline (M = 60.7% vs. M = 53.2%), and reported a slightly larger shift in positive attitudes at the end of the course as shown in Table 1. IA students reported higher initial agreement than the baseline for four of the five individual factors, with the exception of Problem Solving – Transfer.

Despite IA students ending with a higher median percentage agreement overall, they ended with lower median percentage agreements than the baseline for three of the five factors: Real-World Connections (Post-survey Median IA 68.2% versus Baseline 75.0%), Personal Interest (Post-survey Median IA 72.7% versus Baseline 75.0%), and Problem Solving – Strategies (Post-survey Median IA 72.7% versus Baseline 83.3%).

The only factor with an average decrease in agreement among IA students was Real-World Connections, with an average decrease of -2.3% agreement compared to an increase of 3.2% agreement for the baseline. In comparison, there were no factors for which students in the baseline group reported a decrease on average.

Problem Solving – Transfer was the factor with the lowest initial and final mean percentage agreement among both IA and baseline students. It was the only factor for which IA students reported a lower initial agreement than the baseline (Median IA 31.8% versus Baseline 50.0%, Mean IA 38.6% versus Baseline 40.3%). IA students reported a greater average increase in agreement for questions in this factor than the baseline (Mean 25.0% shift for IA versus 9.2% shift for Baseline), ending with a higher final agreement in the post-survey (Median IA 63.6% versus Baseline 50.0%, Mean IA 63.6% versus Baseline 49.5%).

IA students began with higher initial scores than the baseline for Problem Solving – Strategies, but ended lower than the baseline after reporting less of a positive shift. This category is related to developing strategies for problem solving specific to computing, such as breaking down a problem and planning before starting to code.

## 5 Discussion

### 5.1 Struggling to Recognize Real-World Connections in Prison

Our results indicate a decline in CS attitudes among IA students in a CS1 course particularly relating to real world connections. To gain additional insight into the results uncovered by the CAS measurements on students’ attitudes toward computing, we searched through students’ open-ended responses in Weekly Reflections for relevant quotes. While the qualitative data collected in the reflection assignments offered insight beyond the students’ responses to Likert-scale questions, the responses were typically limited to 1-3 sentences. There was no qualitative data collected from the students directly asking them about their attitudes toward computing. Therefore, we present these quotes as potential explanations for our quantitative results while recognizing the need for more future work in this area.

When asked in an open-ended short-answer question in the first week of class what they were most looking forward to about the course, several students specifically mentioned learning how to use Python or computer science in "real world" scenarios (e.g., "... Knowing how to use python in a real world situation," "...understanding how coding relates to real world problems..."). One potential explanation for the decline in attitudes specifically relating computing to the real world with these responses in mind is that students began with high expectations that were not met through the course. In a related prior study outside of CS comparing the experiences of incarcerated and non-incarcerated students participating in an Inside-Out program in Australia found through qualitative analysis using focus groups that while both groups of students mentioned developing professional skills through the experience, the non-incarcerated students specifically discussed how they could “clearly see the transferability of skills they had learned in Inside-Out” in their jobs outside as case managers [23]. In future work, more thorough investigation of what real world connections are specifically of interest to incarcerated students could provide a fuller picture to instructors, and help facilitate more open communication between instructors and incarcerated students about how an introductory course may fit (or not) with these goals.

One example reflecting the ability to make real world connections with the material was a student who related the coding process to his former occupation as an electrician: "... I really enjoy trouble shooting... Finding the fault in the code is similar to find a problem in circuitry." This aligns with a core tenet of andragogy theory, leveraging prior life experiences –including work experiences– in the classroom [10, 31], and with prior qualitative results in CS education finding that adult learners used their lived experience as a resource [29]. As noted in a recent literature review on adult learners in CS education, creating strategies drawing on andragogy theory could improve attitudes and outcomes for adult CS students in the future [2]. For example, these connections to past work experiences could be made more explicit in the form of reflection assignments or guided conversations.

## 5.2 Difficulty Maintaining Personal Interest

IA students also reported a lower median percentage agreement with experts at the end of the course compared to the baseline on statements related to personal interest, despite reporting median percentage agreement higher than the baseline on the pre-survey. Several responses from students indicated a lack of personal interest in the subject due to there not being opportunities to take more classes in CS, and not being able to run their own code. As one student wrote, "...initially I was excited about the material, however, I'm a little disappointed that there is not a follow up to this class..." Another student wrote, "The practice code submissions were challenging for me. Waiting 24 hours just to be told that you forgot a colon at the end of a function, if-statement, etc. is sort of a motivation killer" (Recall from Section 3.2 that as a substitute for students being able to run their own code, the instructor ran code submitted by students to Canvas and returned the output to them once daily). While these responses are disheartening in that it appears students lost interest due to restrictions in the prison environment, they also provide hope that incarcerated students in the future could benefit from shifting policies to enable more access to education in prison and increased technology infrastructure. For the time being, as the majority of college in prison programs in the U.S. and elsewhere continue to restrict critical technologies for teaching CS1, more work is needed to create strategies for developing students' positive attitudes towards CS in spite of these barriers in addition to identifying the ways in which these policy decisions impact incarcerated students' experience and performance in computing courses.

## 5.3 Incarcerated Students Reported More Positive Attitudes Than Non-Incarcerated

One of the major findings from our second research question was that the incarcerated students in our study, overall, reported higher initial and final agreement with experts, as well as a slightly greater positive shift over the course, than the baseline reported in prior work for introductory CS students. A positive shift in attitudes towards computing among adult learners after a learning experience in CS has been been reported in several prior works [2, 9, 29]. However, our results from a course predominantly made up of students from racial groups underrepresented in CS (see Section 3.1) conflict with a previous finding that students from racial groups underrepresented in CS reported no shift in attitudes [19]. Additionally, our findings resonate prior work outside of CS comparing related aspects of educational experiences between incarcerated and non-incarcerated students. One study comparing quantitative survey data from 58 incarcerated women participating in a HEP program with a matched sample of non-incarcerated women also found that reported well-being, coping, and academic engagement was higher among the incarcerated students [26]. Another study taking place in an Inside-Out program (an implementation of higher education in prison where students from the main campus of an institution travel to a prison to participate in class alongside incarcerated participants), 48 incarcerated and 47 non-incarcerated students across three courses conducted in US prisons completed pre- and post-surveys related to general self-efficacy [3]. While not discipline-specific, and measuring self-efficacy as opposed to attitudes toward a subject, the survey contained several items similar to those on the CAS (e.g., "I can solve most problems if I invest the necessary effort"). Incarcerated students in this study reported lower self-efficacy initially compared to non-incarcerated students, but a statistically significant increase to a higher final measure of self-efficacy than the non-incarcerated students [3].

## 5.4 Limitations and Future Work

Primary limitations include a necessarily small sample size, representing students incarcerated at one male prison. As prisons typically cannot accommodate large class sizes, supporting generalizations about computing attitudes among incarcerated college students will require future studies across multiple facilities, including women's prisons, those in different geographic locations, and with different security levels that dictate environmental restrictions such as access to educational technology and resources. Additionally, these results represent the 55% of students who submitted both the pre- and post-reflection assignments and answered the filter question correctly on both. We found that these eleven students had a higher average final grade percentage (93.85) compared to the other nine students (77.86), which indicates another opportunity in future work to find ways to capture the attitudes of more students who are struggling in the course. However, we note that for comparison to the baseline in [12], the prior study had the same requirements for inclusion (submitting both a pre- and post-survey, and answering the same filter question correctly on both) and reported a similar percentage of inclusion (see Section 3.4).

# 6 Conclusion

This work set out to identify shifts in attitudes towards computing among incarcerated adult (IA) college students in a CS1 course, and whether they differed from those of non-incarcerated students reported in prior work [12]. We report the results from pre- and post-measurements using the validated Computing Attitudes Survey (CAS) instrument. Major findings include:

- The IA students reported more positive initial and final attitudes towards computing than non-incarcerated students
- IA students reported statistically significant positive shifts in computing attitudes for two sub-factors: Problem Solving – Fixed Mindset, and Problem Solving – Transfer
- Despite an overall positive shift, IA students reported a decline for the Real-World Connections factor, although neither was statistically significant

As a result, future work on improving introductory computing education for incarcerated college students should leveraging students' personal experiences to make better real-world connections to computing more explicit, which could foster more positive attitudes towards computing among this student population.

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