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Improving Undergraduate Computing Engagement with Computing Fellows Across Disciplines

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Abstract

This paper explores the efficacy of near-peer computing mentors in fostering computing identity among students in courses across disciplines. The Computing Fellows program "attaches" near-peer mentors to a wide range of undergraduate courses to create a cross-disciplinary learning environment for mentors and students. The mentors support the integration of computing into courses through activities including in-class workshops, one-on-one consultations, and drop-in office hours. Prior research has established the positive impact of near-peer mentoring on students' sense of computer science identity in computer science educational pathways. Our paper contributes to this literature by studying the experience of near-peer mentoring for students in courses across disciplines, including in courses in which there is no coding prerequisite. Our research demonstrates a positive relationship between increases in key aspects of computing identity and interaction with a computing fellow. In a multi-year mixed-methods study, we analyze student evaluations from courses with attached fellows and cross-reference the results with student focus group data. Among our findings, students who say they met with a fellow at least once demonstrate a reported increase in computing interest (not seen in our full sample) and computing competency (larger than in our full sample). These increases also hold among the sub-group of students in courses with no coding prerequisites. Our qualitative data further shows the variety of ways students describe the impact of computing fellows on their engagement with computing.

CCS Concepts

• **Social and professional topics → Computing education**.

Keywords

undergraduate, peer mentoring, cross-disciplinary, computing

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1 Introduction

Computing is useful in nearly all disciplines and career pathways today. Nonetheless, undergraduate students—particularly women—can feel daunted by the idea of coding and learning to code [38]. Peer and near-peer mentoring programs in STEM fields have been shown to support self-efficacy and a sense of belonging and inclusion for students, particularly women and students from underrepresented groups [15, 30, 40]. In this paper, we study how undergraduate students are affected by having a peer or near-peer mentor (here, "fellow") available to support computing activities within their courses. The Computing Fellows program we study attaches fellows to courses across disciplines in order to support engagement with computing in the context of the courses' disciplines. The involved courses are mostly either courses outside the Computer Science (CS) department or introductory computing courses for non-majors. In their work with students, the fellows are considered peers or near-peers since they all have computing experience and expertise, while the students in the courses may not. Our program and research is situated in a women's liberal arts college associated with a large university; all fellows identify as women or nonbinary, as do the majority of the students they serve.

The Computing Fellows program hires undergraduate students to be computing fellows and trains them through a cohort model. The fellows are matched with undergraduate courses across disciplines (so far including environmental science, chemistry, neuroscience, CS, history, education, economics, and French) in order to support the integration of computing in the courses. The program aims for students across disciplines to experience the utility of computing and to feel empowered to learn more.

As part of a multi-year mixed-methods study, we are studying the experience of both the course students (the students in the courses that fellows are attached to) and the fellows. Building on our earlier results developing instruments and studying the experience of the fellows [33, 34], this paper focuses on the program's influence on the course students through the research question: RQ1: *How do Computing Fellows contribute to course participants' engagement with computing*? Our work combines analysis of quantitative course evaluation data with nested qualitative analysis of open-ended prompts in the course evaluation data and of student focus groups.

We find a positive relationship between interactions with computing fellows and increased self-reported computing interest and competency among students in the courses. Our primary findings are: (1) students overall report strong agreement that computing will be useful in their future studies and careers, (2) students who say they met with a fellow at least once demonstrate a self-reported increase in both computing interest and computing competency not seen in our full sample, and (3) these increases also hold among the sub-group of students in courses with no coding prerequisites. Our qualitative data supports these results, showing the variety of ways course students describe the impact of computing fellows on their engagement with computing.

We describe the Computing Fellows program in more detail in Section 2. We discuss related work in Section 3 and describe our research methods in Section 4. We present our results in Section 5 and conclude with additional discussion in Section 6.

Positionality of Research Team. Our research team members all identify as women, two as women of color. We come from a broad range of disciplinary backgrounds and expertise, including CS, education, social science, anthropology, and design.

2 Computing Fellows Program

In the Computing Fellows program, fellows are "attached" to courses at the college across the sciences, humanities, and arts. Fellows work with program staff, course faculty, and course students to support student learning. They can be attached to courses in one or more ways: teaching a workshop on computing-oriented topics related to the course, offering office hours, or offering in-class consultations for computing-related assignments or projects. The program also provides training for the fellows through weekly meetings, which cover inclusive pedagogy (e.g., anti-racist pedagogy), sociotechnical issues in computing (e.g., data feminism), and refinement of technical skills (e.g., practice with MATLAB). The Computing Fellows program promotes the inclusion of computing across the liberal arts curriculum, ensuring that students are exposed to the value of computing in disciplinary-specific and accessible ways. By attaching fellows to courses to accompany the computing learning experience, the program intends to lower barriers to—and reduce the stigma of—students asking for computing help, thereby improving the chances that they feel more competent in their own computing abilities.

Many fellows return for multiple semesters and additional new fellows are hired at the beginning of each academic year. Fellows are selected based on applications and interviews, with the selection criteria including applicants' teaching and computing experience, as well as interest in learning more and in peer mentorship. Each semester, faculty across the college have an opportunity to request a Computing Fellow for their courses. Courses can feature computing as an already integral topic or can add a modular computing activity that highlights the value of computing in their discipline. For courses that do not have an existing computing activity, the program works with instructors to develop appropriate activities. Fellows are matched to courses according to their interest, availability, and familiarity with relevant coding languages or computing-related topics. For example, in an environmental science course, students met with fellows in class for help with cleaning, analyzing, and visualizing students' datasets. In an education class, a fellow assisted with developing and teaching in-class workshops for data visualization and storytelling using education policy data.

3 Related Work

Research has demonstrated the value of CS pedagogy and culture that fosters community-oriented learning and strengthens students' self-efficacy, especially in introductory courses [19, 45]. Creating and sustaining such environments is key to promoting inclusivity and reducing attrition from introductory courses [4]. These changes are also critical to transforming the culture and reputation of the discipline in order to support a greater diversity of students to continue their computing education [14, 27, 46].

Mentoring programs have been shown to increase student retention and academic success [12, 28, 31, 37]. Having a diverse range of mentorship opportunities, including near-peer mentoring, provides access to meaningful academic, social, and professional support for undergraduate students [11, 23, 26, 39, 44], especially for women and people from groups underrepresented in STEM [3, 20]. Through these relationships, both mentors and mentees develop a stronger sense of belonging and science identity, and feel more integrated with their institutions [21, 23, 42]. Near-peer mentorship allows course students to participate in knowledge production [40] and potentially provides higher psychological and emotional support as compared to traditional mentorship relationships with computing faculty [47], while also supporting these traditional mentoring relationships [13, 35]. The unique position of near-peer mentors helps build rapport with course students [40] by enhancing students' self-efficacy through social connections and perceived similarities, and by modeling and demonstrating effective performance [1, 2].

Computing identity has been defined in various ways, describing how computing interest, skills, and community contribute to one's conception of self [7, 9, 17]. Some scholars emphasize students' feelings of competence, pride, and belonging [6, 24], while others forefront complex social negotiations of computing identity—which can be particularly challenging for women of color, who must also contend with how others question them and their legitimacy in the field [8]. Scholars have explored how these factors impact students' ability to foster meaningful connections or interest in computing, which are essential for students to persevere in the field [9, 25]. Building on earlier work on disciplinary identity frameworks [18], other scholars show how perceived recognition and interest are highly predictive of students' persistence in CS [25].

Scholarship on near-peer mentorship programs is fairly extensive, but the impact of near-peer computing mentorship on the development of computing identity in non-CS disciplines has received little attention. Our study contributes to this conversation by exploring how self-perceptions of computing competency and interest changed for students in courses across disciplines with integrated computing content and a near-peer computing mentor.

4 Research Methods

Our mixed-methods research design is based on previous studies in mixed-methods CS education research (e.g., [5, 10, 36, 43]). We use a concurrent nested strategy to embed qualitative data collection within quantitative data collection [41]. Our mixed-methods approach was informed by the multiple limitations of quantitative research in complex educational contexts where independence of observation is not guaranteed. The quantitative design uses questions added to institutional course evaluations, seeking to examine how aspects of computing identity change for students who meet with a fellow. We further draw on qualitative data from focus groups and open-response prompts on the course evaluations to better understand the variety of ways students describe the impact of fellows on their engagement with computing, as well as some students' reasons for not interacting with a fellow.

4.1 Sample and Measures

Our sample is composed of a self-selected subset of students in courses with an attached computing fellow. We gathered data from course students in two ways: (1) optional course evaluation questions that were appended to our institution's standard course evaluation instrument and collected at the end of the semester and (2) optional focus groups conducted in the last third of the semester. We draw on course evaluation data from Spring 2023 (N=120), Fall 2023 (N=190), and Spring 2024 (N=160) and focus group data from Fall 2023 (N=5) and Spring 2024 (N=5), with priority given to the course evaluation data due to consistent findings in the course evaluations and limited participation in focus groups. In the course evaluations, we find the same major trends hold across all semesters. Accordingly, in this study, we combine data from all three semesters into one larger dataset to better examine differences between types of courses and degree of engagement with a computing fellow.

Drawing on the literature on computing identity [18, 25], we focus on three major outcomes of interest: (1) self-reported competency in computing, (2) self-reported interest in developing computing skills, and (3) self-reported usefulness of computing to future work or studies. To measure competency and interest, we included retrospective pre-post survey items [16] on an end-of-semester course evaluation survey. A question about perceived usefulness of computing was also included. All scaled items on the survey used the following five-point scale: 1=Strongly Disagree; 2=Disagree; 3=Neither Agree Nor Disagree; 4=Agree; 5=Strongly Agree. The survey instrument is available at [22].

To understand the extent of student engagement with the fellows, we asked students to indicate the number of times they met with a fellow on a survey item with the following response options: 0 times, 1 time, 2-3 times, 4-5 times, 6 or more times. We then recoded this data into an additional variable that grouped students who met with a fellow zero times (*Zero Interactions*) and those who met with a fellow one more or more times (*One+ Interactions*) to isolate non-interaction vs. interaction. Fellows are attached to courses from a variety of disciplines that require varying degrees of prior coding knowledge. To better analyze the experience with fellows based on assumed prior coding experience, we created a variable based on whether a course did or did not require coding skills as a prerequisite (henceforth, "prereq"). Courses that require coding skills (i.e., specific coding languages or a general background in coding), as stated in the official course directory, are categorized as *Code Prereq*; courses that do not are categorized as *No Code Prereq*.

Because this study examined students enrolled in courses across disciplines, the sample includes a mix of CS and non-CS majors. Where possible, we inferred students' majors through a standard course evaluation question that asks students if their major is the subject of the course, a related subject, unrelated to the course, or undecided. Applying this inference across our three-semester sample, 41 students were CS majors, 112 neuroscience majors, 81 environmental science majors, and 14 education majors, among other majors with smaller numbers (e.g., French, economics, chemistry). Many students also indicated their major was in a related or unrelated area or that they were undecided. Given the limitations to the standard major question, we did not disaggregate by major, but we did cross-reference students' responses to this question to contextualize specific cases in quantitative and qualitative findings.

In addition to the quantitative data from the course evaluations, we have two sources of qualitative student data. First, we included open-response prompts in the course evaluations to learn about how students interacted with fellows and how fellows impacted students' experience of the course. Second, focus groups explore students perceptions about computing and the computing fellows. In the semi-structured focus groups, we ask students about their motivations for taking the course, their previous computing experience, the nature of the fellows' involvement in the course, and how the fellow(s) impacted their engagement with computing, among other questions. The focus group instrument is available at [22].

4.2 Analysis Methods

Our course evaluation data does not follow a normal distribution, so standard statistical tools that assume normality are inappropriate for our analysis. Accordingly, we use the nonparametric Wilcoxon signed-ranks test and Mann-Whitney U test (MW) to analyze our quantitative data, along with effect size calculations ($r=Z/\sqrt{N}$) [29, 32]. Specifically, we use the Wilcoxon signed-ranks test to compare the differences between the medians of paired retrospective pre-post questions, and the MW test to compare the distributions of changes in responses between independent groups (e.g., *Zero Interactions* vs. *One+ Interactions*). A significance threshold (α-value) of .05 is used for all statistical tests, and two-tailed p-values are calculated to determine statistical significance. Although the data is not normally distributed, we report means to provide supplementary context about the distribution's characteristics.

For our qualitative analysis, responses to the open-response prompts on the course evaluations were analyzed using open coding to identify relationships between student learning experiences and changes in course students' perceived usefulness of computing as well as their sense of competency and interest in computing.

For the semi-structured student focus groups, we combined deductive and inductive thematic analysis both to understand our main factors and to allow for emergent themes to develop. As described in our earlier work about instrument development [33], our research questions and indicators guided the development of the focus group questions and set parameters for relevant topics in our thematic analysis coding process. We also identified emergent

# Interactions		Usefulness			Pre-Competency			Post-Competency			Pre-Interest			Post-Interest		
		N	Mdn	M	N	Mdn	M	N	Mdn	M	N	Mdn	M	N	Mdn	M
(full sample)		430	4	4.29	405	3	3.06	399	4	3.96	405	4	3.79	404	4	3.89
	0	179	4	4.29	162	4	3.25	157	4	3.80	162	4	3.85	160	4	3.79
	≥ 1	251	4	4.27	243	3	2.93	242	4	4.06	243	4	3.75	244	4	3.96
No Code Prereq	0	163	4	4.28	146	3	3.22	141	4	3.80	146	4	3.82	144	4	3.77
No Code Prereq	≥ 1	243	4	4.26	235	3	2.90	234	4	4.07	235	4	3.73	236	4	3.95

Table 1: Course Students' Self-Reported Usefulness of, Competency in, and Interest in Computing

themes based on participant responses. In this concurrent nested mixed-methods study with a quantitative focus, we draw on coded focus group data to further explore the complexity of students' perspectives for relevant measures.

5 Our Results

Our study provides evidence that mentoring and peer support provided by the Computing Fellows program has a positive association with changes in computing interest and competency. Students report strong agreement that computing will be useful in their future studies and careers (details in Section 5.1). In retrospective pre-post questions in the course evaluations, students who met with a fellow at least once demonstrate a reported increase in computing competency larger than in our full sample (Section 5.2) and a reported increase in computing interest not seen in our full sample (Section 5.3). Furthermore, these increases hold among the sub-group of students in courses with no coding prereq.

Students enrolled in courses with attached fellows have a wide variation in majors across STEM, humanities, and the social sciences; some students have prior coding experience and others do not. Courses with attached fellows including at least some computing content, such as introductions to coding languages (e.g., Matlab, Python, R), applications of coding (e.g., data visualization), other computing topics (e.g., data privacy, CS education), or other computing technology (e.g., Tableau, GenAI). We summarize the quantitative course evaluation responses in Table 1 and provide quantitative and qualitative analysis in the rest of this section.

5.1 Usefulness of Computing

Students across our sample overwhelmingly report that computing is useful to their future work and study. Our usefulness measure consistently returned high mean (M) and mediam (Mdn) responses compared to other questions. Even when broken down into different subgroups, the average response was at least 4 (out of 5), well above the range of other questions in the course evaluations.

Our focus group data corroborates this quantitative evidence. Students representing a wide array of majors discussed the importance of computing skills to their studies, disciplinary research, and future career prospects. This led many students to enroll in a course included in this study; others developed this sense of usefulness partly through the fellow-enabled computing activities in the courses. In Fall 2023, for example, two environmental science majors enrolled in an environmental science course discussed the importance of computing for sustainability policy and research. One student was explicit that she values computing as a tool to interpret science for decision-makers and policy around sustainability. In a different Fall 2023 focus group, two neuroscience students enrolled in different neuroscience courses with an attached fellow discussed how computing skills were fundamental to their future career interests in neuroscience. As one student explained, she took the course because "*if you want to work in… a neuroscience lab or [do] neuroscience research, having some experience even in one language, being used to thinking in that way and being adaptable to different [coding] languages… it's important to have some experience, even if you don't want to do that as your career.*"

Another participant extended the discussion of the utility of computing to developing a deeper understanding of neuroscience itself: "*I feel analyzing our results through computing did a lot, because sometimes you go through the motions and you do something because you're told to do it, like 'Okay, pipette X amount into this and look at this,'*" but when asked to use computing to explore results of the experiments, "*it helped put the pieces together of what I was really doing.*" She described previous negative experiences in coding courses, noting that her new confidence in computing and her new understanding of its value have made her want to continue: "*I actually want to do more computing in the future just because it's so useful, but I feel better about potentially doing that.*"

In the open responses in the course evaluations, many students described how their courses have influenced their career development. Responses varied from straightforward reflections, such as neuroscience majors noting that newly developed Matlab skills will enhance their research and job prospects, to an education major observing that they now understand "*how computational methods can be used to represent data, stories, and historical information.*" Additionally, some responses indicated deeper changes, like a CS major explaining how discussions about data privacy, technology, and ethics have altered their perception of their social responsibility as a future computing professional.

5.2 Self-Perception of Computing Competencies

In our study, students generally report an increase in computing competency from the beginning to the end of the semester. There is an increase in the pre-competency measure (mean M=3.06, median Mdn=3) to the post-competency measure (M=3.96, Mdn=4). (See Table 1.) The Wilcoxon signed-ranks test for the paired samples pre- and post-competency indicate a statistically significant increase ($Z=-11.11$, $p<.001$, $r=.74$) in perceptions of computing competency from the start to the end of the semester. These results indicate that students' self-perception of their computing competencies throughout a semester significantly increased across the sample.

We subdivided the data by two variables, *Number of Interactions* and *Coding Prereq*, in order to understand if interactions with a fellow have a relationship to changes in competency for students in courses for which there are no prereq coding requirements. For responses from students who met with a fellow zero times, there is an increase in the pre-competency measure (M=3.22, Mdn=3) to the post-competency measure (M=3.80, Mdn=4). For students who met with a fellow at least once, there is a larger increase in the pre-competency measure (M=2.90, Mdn=3) to the post-competency measure (M=4.07, Mdn=4). Results of the Wilcoxon signed-ranks tests for both *No Coding Prereq/Zero Interactions* (Z=-5.52, p<.001, r=.71) and *No Coding Prereq/One+ Interactions* (Z=-9.74, p<.001, r=.79) returned statistically significant p-values and large effect sizes (r).

Comparing the distribution of changes between the two subgroups, the MW test shows a statistically significant difference (U=12336, Z=-4.14, p<.001, r=.21) between the *Zero Interactions* and *One+ Interactions* subgroups in courses where there is no coding prereq. The MW mean rank for students with *One+ Interactions* (204.06) is larger than those with *Zero Interactions* (158.61). This shows that students who met with a fellow tend to have a larger increase in competency than those who did not. Despite the small effect size (r) on the MW test, the difference is significant (p<.001) and suggests that interactions with fellows are associated with positive changes in perceived computing competencies for students in these courses.

To explore these results qualitatively, we included two open-response prompts (ORP) in the course evaluations, ORP1: *What kinds of interactions have you had with the Computing Fellow(s) attached to your course? How did they impact your experience with the course?* and ORP2: *Based on your experience in this course, how has your understanding of computing changed or evolved, if at all?* The responses from both questions provide broader and deeper context for the ways in which working with a fellow shaped students' experiences.

From the open coding of ORP1 and ORP2 for *One+ Interactions*, we identified recurrent trends that indicate three ways in which having a fellow facilitated learning in the course: fellows were accessible, they provided individualized support, and they made students feel comfortable seeking help. Students reported that fellows were accessible both in and outside of class, that they were responsive over email, and that they helped give feedback within a time frame that helped with assignments and projects. Students also reported that fellows provided feedback that was tailored to the students' specific computing skill level. Additionally, many responses reported that a fellow was kind, supportive, and encouraging, and made students comfortable and confident to ask questions.

In focus groups, students extended this discussion to reflect on how their work with a fellow bolstered the development of computing competencies. As one neuroscience major explained in Fall 2023, her fellow's pedagogical approach allowed her to problem solve between neuroscience content and computational tools, stating that, "*I asked [the fellow] a problem and instead of being like, 'Oh, figure it out,' or even giving me the answer, she really helped me think through it. And she was like, 'Oh, look at this and compare it to that—Have you thought about why?' And I really understood it.*" When this student had first signed up for the course, she explained, "*I was nervous... I was like, 'Oh, not coding again!'… I feel the way [Matlab has] been presented to us… is really encouraging learning. So I like that. It's everything that Java wasn't. It's really not like, 'Can you code this and that?' They will tell you, they will help you figure it out. I feel way better about it now. I actually like doing it a little bit more because I felt supported in [this] class.*"

In another Fall 2023 focus group, a student majoring in environmental science (ES) and minoring in CS had a fellow in an upper-level ES course. She felt confident in her computing competencies before entering the class, stating that "*I was familiar with [Python], so I wasn't intimidated.*" However, the environmental science project in the course required using Python for data analysis which she had not encountered in her CS coursework. As she explained, "*We were going to work with Python, and I didn't know how that works with data. I've never done it before. So that was helpful to have [the fellow] there… For me, it was a lot less intimidating. It's not as hard as I thought it would be.*" In a Spring 2024 focus group, a CS major enrolled in an education course focused on teaching CS in K-12 settings described how her sense of computing competency itself had expanded as a result of the course. As a graduating senior, the student reported high confidence in her computing skills. Through her work in the course, facilitated by modular workshops and office hours with fellows, she developed competency in "*taking complex topics and explaining them to someone who has no background*," which instead of being auxiliary or separate from computing, she positions as fundamental to any computing career: "*You need to be able to communicate with other people*," she explained, "*what your needs are, meeting customer needs, or how to ask for help*."

In the responses to ORP1 and ORP2 for students reporting zero interactions with a fellow, the majority of responses did not provide additional context. However, for the students who did, we identified four recurrent trends: (1) they had previous relevant CS experience, (2) they utilized other resources (e.g., professors, advisors, and TAs), (3) they were unaware of the fellow, or (4) they had difficulty scheduling times to meet with their fellow.

5.3 Interest in Developing Computing Skills

Another set of retrospective pre-post questions measures the change in interest in developing computing skills before and after the course. (See Table 1.) Across the aggregate data, there is an increase from the pre-interest measure (M=3.79, Mdn=4) to the post-interest measure (M=3.89, Mdn=4). The results of the Wilcoxon signed-ranks test indicated a statistically significant increase (Z=-2.22, p=.03, r=.20) in interest in computing from the pre- to the post-interest measure. We again subdivided these responses by *Number of Interactions* and *Course Prereq*. In courses with no coding prereq, we see a decrease from the pre-interest measure (n=146, M=3.82, Mdn=4) to the post-interest measure (n=144, M=3.77, Mdn=4) for students who did not meet with a fellow. For students who did meet with a fellow, there is an increase from the pre-interest measure (n=235, M=3.73, Mdn=4) to the post-interest measure (n=236, M=3.95, Mdn=4). The results of the Wilcoxon signed-ranks test for *No Coding Prereq/No Interaction* are not statistically significant (Z=-.37, p=.71, r=.06), while the results for *No Coding Prereq/One+ Interactions* show statistical significance (Z=-3.19, p=.001, r=.35).

The MW test demonstrates a statistically significant difference (U=14843.5, Z=-2.25, p=.03, r=.12) between the *Zero Interactions* and *One+ Interactions* subgroups in courses with no coding prereq. In these courses, students who reported interacting with a fellow have a higher mean rank (197.07) than those who did not (175.80), indicating larger positive changes for students who interacted with a fellow. Despite the small effect size (r) of the MW test, the difference is significant (p=.03) and suggests that interactions with computing fellows are associated with positive changes in interest in developing computing skills for students in these courses.

Turning to qualitative analysis of ORP1 and ORP2, students often associate their interest in learning more computing with their research, labs, courses, or careers. A student with previous coding experience explained that the fellow helped broaden their knowledge of Python packages, stating that the course "*has allowed me to feel confident with the basics of Data Science, and I am interested to learn more.*" Another student with no previous computing knowledge also reported that the fellow deepened their understanding of Python and expressed an interest in using what they learned to understand the statistics presented in their major's Psychology courses. Both of these students reported no change in computing interest between pre- and post-interest measures; their interest both started and ended high (Agree and Strongly Agree, respectively).

The theme of cross-disciplinary application of computing recurred in the open responses. A student who reported pre-course perceptions of low computing competency (Pre-Competency=1 Strongly Disagree) but positive interest (Pre-Interest=4 Agree) stated "*I have gotten really excited about Computing through this course! I hope to learn more about computing in interdisciplinary contexts– how computer science can be used as a tool for many different contexts,*" which the student attributes in part to a workshop a fellow developed and gave on data feminism in their course. This student reported an increase in both competency and interest on their post questions (Post-Competency=5 Strongly Agree, Post-Interest=5 Strongly Agree). A neuroscience major who recounted previous negative experiences in an introductory coding course stated that the support she received from the fellow changed her perception regarding her ability to learn coding: "*The support from the computing fellows is great; even though I'll never be an expert, I feel like coding is something I can do, or at least continue to learn how to do*" (Pre-Competency=2 Disagree, Post-Competency=4 Agree). Another neuroscience major who reported meeting with fellows several times also explained, "*I am now much more interested in computational neuroscience. thanks to all of the computing fellows attached to this class. I appreciated your help*" (Pre-Competency=3 Neither Agree Nor Disagree, Post-Competency=5 Strongly Agree, Pre-Interest=4 Agree, Post-Interest=5 Strongly Agree).

6 Discussion and Conclusion

Our findings demonstrate that course students value computing in their studies across disciplines and that interacting with Computing Fellows is positively associated with increased competency and interest. Across the sample, students perceive themselves developing computing competencies and articulate the usefulness of computing to their future work and study. Our qualitative findings also reveal that some students develop this awareness of the value of computing throughout the course, including in their interactions with the computing fellow.

We find statistically and practically significant gains for students who met with a fellow at least once, including increases in competency (greater than the full sample) and increases in interest (not found in the full sample). These findings support prior research on the benefits of near-peer mentorship on students' engagement with computing.

Adding to the literature on peer mentorship, our findings demonstrate the benefits of computing fellows for students across disciplines, with strong evidence for the value of near-peer mentorship in courses with no coding prereq. Qualitative findings reveal that fellows support students both with learning new coding languages or computing skills and with fostering a sense of self-efficacy in future computing endeavors. Building on the interest and sense of usefulness course students bring to the class, fellows support students in developing problem solving skills, navigating negative perceptions of their own capabilities, and persevering in complex coding tasks. Taken together, our results suggest that fellows create an inclusive learning context where students across disciplines can engage with computing and begin to develop or further foster a computing identity.

Though we do not have the ability in our current study to compare students who have prior coding experience to those without prior coding experience, our qualitative data suggests that fellows can be beneficial to both groups and that near-peer mentors can support students with prior coding background in ways the students did not initially expect. For example, a student in an advanced education course with prior coding experience was able to develop their skills in teaching computing; another student with prior coding experience was able to learn a new use for a coding language after initially perceiving that the fellow would not be of use to them. These examples indicate some of the creative ways fellows meet students where they are, as well as how fellows bring their own interest in teaching computing to their engagement with students.

As an area for further study, we plan to explore why some students with access to computing fellows do not draw on this resource. On the one hand, it may reflect that computing fellows are one facet of a larger constellation of resources at our institution, which also includes TAs, tutoring sessions, office hours with a professor, and participating in lab classes. On the other hand, the positive benefits of meeting with a computing fellow suggest that more can be done to support course instructors in relaying the relevance of this program to their students.

Our program and study take place at a small liberal arts college for women, which is affiliated with a larger coeducational "R1" institution. Only students from our college are eligible to be fellows; the course students include students from both institutions due to cross-registration. The Computing Fellows program is an avenue by which fellows contribute to the building of a woman- and nonbinary-focused pedagogical space. This unique setting provides a rich area of study for our program; nonetheless, it may also be a limitation regarding the replicability and generalizability of our results. As future work, we hope to work with other institutions to develop similar programs and study their effectiveness across a broad range of educational contexts.

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