Supporting Mutually Beneficial Near-Peer Mentoring Relationships Within Computing Education Programs

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***Abstract*—Near-peer mentoring has proven to be an effective strategy for supporting students from underrepresented groups in computing. In this paper, we present results from Rise Up and Sisters Rise Up to examine the experiences of mentors in near-peer mentoring programs. Rise Up and Sisters Rise Up are mentoring program initiatives that help secondary students from underrepresented groups succeed in their Advanced Placement Computer Science courses and exams. Drawing on the results from a mixed-method study, we focus on the experiences of mentors to address the following research question: How do near-peer mentoring experiences impact mentors' competency beliefs related to programming, mentoring, and culturally responsive teaching? Findings from the analysis of survey and interview data indicate that serving as a near-peer mentor reinforced mentors' prior programming knowledge, increased their programming self-efficacy beliefs, and prompted self-reflection on the purpose of mentoring relationships. In addition to these benefits, the results also revealed the need to provide mentors with continued opportunities to build mentoring competencies and practice culturally responsive teaching strategies. We conclude by discussing future work to improve our mentor training and further develop a mutually beneficial near-peer mentoring model for computing education that supports the development of mentors, as well as mentees.**

***Index Terms*—mentoring, computer science, underrepresented minorities**

I. Introduction

Near-peer mentoring has proven to be an effective strategy for supporting students from groups who are underrepresented in computing, including women, Black/African American, Latina/o/x, and Native American students [1]. While the impact of near-peer mentoring relationships on mentees has been widely studied, less is known about how mentoring relationships impact *mentors* who participate in computing education programs. The aim of this research is to develop a mutually beneficial near-peer mentoring model that promotes and assesses the academic and professional growth of mentors, as well as mentees. In this paper, we report on the first stage of our efforts and present results from a mixed-method study that examines the impact of near-peer mentoring relationships on mentors' competency beliefs within the context of an out-of-school computing education program.

We collected survey and interview data from mentors participating in the programs to address the following research question: *How do near-peer mentoring experiences impact mentors' competency beliefs related to programming, mentoring, and culturally responsive teaching?* Findings from the analysis of mentor survey and interview data indicate that serving as a near-peer mentor reinforced mentors' prior programming knowledge, increased their programming self-efficacy beliefs, and prompted self-reflection on the purpose of mentoring relationships.

In addition to these benefits, the results also revealed the need to provide mentors with continued opportunities to build mentoring competencies and practice culturally responsive teaching strategies. We conclude by discussing future work to improve our mentor training and further develop a mutually beneficial near-peer mentoring model for computing education that supports the development of mentors, as well as mentees.

II. Literature Review

A. Near-Peer Mentoring

Near-peer mentoring is a process in which students or professionals of a similar age serve as a mentor to someone with less advanced training and education [2], [3]. Within an effective near-peer mentoring relationship, both mentees and mentors are able to experience academic, professional, social growth [4]. In terms of academic outcomes for mentees,

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research has shown that near-peer mentoring positively influences their understanding of subject matter and the development of a disciplinary identity [1], [5]. Similarly, mentors report an increased understanding of the subject matter they are teaching mentees, bolstering of their own science identity, and increased persistence in the academic field [1], [6]. Beyond academic and professional outcomes, near-peer mentoring has also been proven to positively impact transferable social skills [4]. For both mentees and mentors, these social skills include strengthened leadership skills, increased self-awareness, a gained sense of responsibility for others, and overall stronger feelings of confidence [1], [6].

B. Near Peer Mentoring in Computing Education

Within computing education, much of the research on near-peer mentoring has focused on highlighting the positive outcomes for mentees [5], [7], [8]. Prior research has shown that mentor relatability, which is perceived as having a mentor with similar connections, was an important factor in building strong mentoring relationships [5], [9]. If mentees could relate to mentors, they often considered them to be greater role models than adult professors [9], even if the mentor was not highly skilled in computer science [5]. One of the significant results of establishing strong near-peer mentoring relationships in computing is an increase in mentees' self-efficacy beliefs [5], [9]. For example, mentees experience an increase in programming self-efficacy through vicarious experiences and performance accomplishments when learning to program with mentors who are similar in age and experience [10], [11]. The impact of near-peer mentoring on self-efficacy beliefs is significant because low self-efficacy beliefs discourage youth, and women in particular, from studying computer science [12]. Other significant results include increasing mentees' interest, connection, and sense of belonging in computer science [12], [13]. For example, the Glitch Game Testers program found that engaging in computational activities with cultural capital, such as paid game testing, could lead to positive relationships between peers and increase African American men's interest in computer science [13].

III. Research Design

A. Program Context

Rise Up (RU) and Sisters Rise Up (SRU) are mentoring program initiatives that help secondary students from underrepresented groups succeed in their Advanced Placement Computer Science courses and exams. The programs offer free two one-hour remote help sessions weekly and one in-person three-hour help session monthly. The help sessions are run by undergraduate mentors and aim to prepare high school students for the the Advanced Placement (AP) Computer Science A (CSA) and Computer Science Principles (CSP) exams. These exams are open to secondary students (ages 14-19) who can take it for college credit and/or placement. The AP CSA exam is meant to be the equivalent of a first-semester course in computer science and assesses students' knowledge of topics like Boolean expressions, if statements, arrays, and recursion.

TABLE I: Mentor Information by Site

Site	Gender	Race	Major	Year
1	W	Black	CS	4th UG
1	W	Black	IT	2nd UG
1	W	Black	CS	4th UG
2	W	Asian	IT	2nd UG
2	W	Asian	Bio. Eng	3rd UG
2	W	White-Asian	CS	2nd UG
3	W	Latina/o/x	CS	3rd UG
4	W	Asian	CS	3rd UG
4	NB/GNC	Asian	CS + Astro.	2nd UG
5	W	Asian	Mat. Sci.	2nd PhD
5	M	Asian	Mat. Sci.+Eng.	2nd PhD
6	U	Asian	CS	3rd UG
7	W	Asian	UND/CS	1st UG
7	W	White	UND/Info.	2nd UG
7	M	Latina/o/x	CS	3rd UG
7	M	Latina/o/x	Info.	4th UG
7	W	White	Info.	4th UG
7	W	White	Info.	3rd UG

Note: W = Woman, M = Man, NB/GNC = Non Binary/Gender Non-Conforming, U = Unknown, UG = Undergraduate

The AP CSP exam assesses students' knowledge of conceptual topics such as algorithms, abstractions, and computing innovations. This paper reports on RU/SRU programs that were offered during the 2019 to 2020 academic year. Since this paper is focusing on the impact of near-peer mentoring on mentors, we will not be reporting on mentee results.

B. Recruitment

Mentors were recruited in the fall by the host universities. The research team provided recruitment criteria, including focusing on undergraduates with knowledge of programming and prior tutoring experience, as well as recruiting mentors who were members of underrepresented groups in computing, such as women of color. Mentors did not have to take part in the research, and were not hired based on their willingness to do so. Although we encouraged sites to hire undergraduate students, some of the mentors were graduate students. Eighteen mentors were recruited across seven sites; of those mentors, sixteen were undergraduate students, and fifteen were computer science majors or in a related field. Fourteen out of the eighteen mentors self-identified as women or non-binary/gender non-conforming. Additionally, sixteen out of the eighteen self-identified as people of color. See Table I for an overview of the mentors' demographic information.

Fifty-two mentees were recruited by the research team, program coordinators at host institutions, and undergraduate mentors who visited high schools. In RU, the mentees were high school students who identify as women or people of color who were taking AP CSA or CSP. They were mentored by undergraduate students at the University of Michigan. In SRU, the mentees were all women of color who were taking AP CSA in the same state as the host institution.

We provide information on the sites and mentees in Table II.

TABLE II: Location, Type, and Number of Mentees

Site #	Location	Type	Total
1	Florida A & M University	CSA	5
2	*Rutgers University	CSA	0
3	George Mason University	CSA	3
4	Texas State University	CSA	4
5	San Jose State University	CSP	4
6	Un. of Maryland- College Park	CSA	15
7	University of Michigan	CSP	11
7	University of Michigan	CSA	10
		Total	**52**

Note: *=site did not participate due to IRB

C. Training

Materials for implementing the programs were shared with host universities. These included free and interactive ebooks for AP CSA and CSP, as well as recruitment materials (sample emails and flyers), consent and assent forms, and program implementation guidelines (program summary, a timeline, and information on how to run kickoffs and help sessions). In addition, the lead coordinator held monthly meetings with the site coordinators to check progress and discuss issues.

Members of the research team hosted a one-time training on culturally responsive teaching practices in the Fall of 2019 [14]. This included a discussion of how to apply the practices in their work as mentors. The mentors shared their ideas with each other through a collective document. Only three of the 18 mentors attended the session, which was recorded and shared with the other mentors. The lead coordinator also conducted training on how to run interactive and engaging help sessions.

D. Data Collection

1) Pre & Post Surveys: The mentor surveys consisted of likert-scale questions on 1) mentoring competencies [15], 2) programming self-efficacy [10], [16], and 3) culturally responsive pedagogy [14]. Given that the response rate varied between surveys as well as survey versions, a two-sided Welch's t-test difference in means was selected to assess both survey constructs and item level differences in the pre and post survey results. This allowed us to include all respondent's data compared to an unpaired t-test (requiring the assumption of equal variances). The number of responses, average pre and post data, and results of the construct level t-tests are included in each relevant findings section. Due to page restrictions, only relevant statistically significant individual items will be discussed.

2) Content Knowledge Test: To assess their preparation for teaching concepts from the AP CS exams, the mentors took a content knowledge test that was created by the research team using questions similar to ones from released AP CS exams.

3) Pre & Post Interviews: The mentor pre-interview included questions on 1) demographic information, 2) interest in computing, 3) sense of belonging in computing, and 4) conceptions of mentoring, and were conducted as the mentors signed up for the study in Nov. 2019-Feb. 2020. The post-interviews with mentors were conducted in May after the AP CS exams. The post-interviews focused on 1) their experience using the e-books, 2) interest in computing, 3) sense of belonging in computing, and 4) their mentoring competencies. The interviews were transcribed by a third-party service and analyzed by three members of the research team. Descriptive codes were developed iteratively, refined through coding application tests, and finalized when all coders reached an inter-rater reliability Cohen's kappa score of at least 0.70. Next the coders conducted thematic analysis and these themes were used in the findings.

IV. Findings

Our analysis of the data focused on the mentors experiences to examine how near-peer mentoring experiences impact their competency beliefs related to programming, mentoring, and culturally responsive teaching.

V. Programming Self-Efficacy

Self-efficacy describes one's belief in their capabilities to execute behaviors that will produce desired outcomes and attainments [17]. These are domain specific capabilities that are not fixed but malleable across context and time. Programming self-efficacy refers specifically to a person's perception of their ability to do activities related to programming, such as staying motivated when working on a program [16].

A. Programming Self-Efficacy Survey Results

In this study, we used modified versions of the Computer Programming Self-Efficacy Scale (CPSES) [16]. The CPSES measures four dimensions of programming self-efficacy using a 7-point likert-scale [16]. Results from the Welch's t-test difference in means can be seen in Tables III and IV. As shown, every factor was found to have a statistically significant gain in self-reported confidence other than self-regulation with Java.

TABLE III: Java Programming Self-Efficacy

Construct & *Sample Item*	*Pre* (n=17)	*Post* (n=8)	*W*elch's t-test
1. Independence and persistence *I could complete a programming project if someone showed me how to solve the problem first.*	5.79	6.62	0.016*
2. Complex programming tasks *I could organize and design my program in a modular manner.*	5.04	6.49	0.003**
3. Self-regulation *I could come up with a suitable strategy for a given programming project in a short time.*	5.31	5.91	0.23
4. Simple programming tasks *I could write syntactically correct statements.*	5.84	6.78	0.025*

Note: Scale is 1 (not at all confident) to 7 (absolutely confident); * p $<$0.05, ** p $<$0.01, *** p $<$0.001

TABLE IV: Python Programming Self-Efficacy

Construct & *Sample Item*	*Pre* (n=13)	*Post* (n=7)	*W*elch's t-test
1. Independence and persistence *I could complete a programming project if someone showed me how to solve the problem first.*	3.33	6.27	0.001***
2. Complex programming tasks *I could organize and design my program in a modular manner.*	2.67	5.96	0.001***
3. Self-regulation *I could come up with a suitable strategy for a given programming project in a short time.*	3.62	5.93	0.006**
4. Simple programming tasks *I could write syntactically correct statements.*	2.91	6.43	0.001***

Note: Scale is 1 (not at all confident) to 7 (absolutely confident); * p <0.05, ** p <0.01, *** p <0.001

B. Programming Self-Efficacy Interview Results

In addition to the survey, we analyzed pre and post mentor interviews for expressions of programming self-efficacy beliefs. In the pre-interviews, mentors were asked "On a scale of 1-10 with 10 being the most confident, how confident do you feel about your computing ability? Please describe why you chose that number." In the post interviews mentors were asked the question again to see if their ranking changed. Additionally, in the post interviews mentors were asked "How has being a mentor for Rise Up or Sisters Rise Up affected your confidence in your computing ability?" and "How has being a mentor for Rise Up or Sisters Rise Up affected your knowledge of computing concepts?" The responses from these questions were coded into two broad categories related to programming self-efficacy: *Knowledge of Computing Concepts* and *Confidence in Computing Ability*.

1) Knowledge of Computing Concepts: Mentors' responses indicated that being a mentor reinforced their knowledge of computing concepts. As Destiny, an African American mentor, said "Rise Up helped me understand more in depth, because sometimes when you're learning something a different way, or if you're talking to somebody and someone says it a different way, you start to understand it more." While mentors expressed an increase in their knowledge of computing concepts, Ashley, a white mentor, also shared that the experience made her realize "there's always more to learn."

2) Confidence in Computing Ability: In the post-interview, mentors' descriptions of their confidence in their computing abilities increased. They reported that coming up with solutions, preparing for help sessions, continuing to use a programming language other than the one they were using in classes, and explaining computing concepts all contributed to an increase in confidence in their computing ability. Mentors were able to identify specific experiences that positively impacted these competency beliefs during post-interviews. For example, April, an Asian American mentor, credited working through solutions with mentees as beneficial "extra practice," while Ashley felt that "teaching these concepts and learning all the math behind" them resulted in a "better understanding" of "why these things work the way that they do."

Interestingly, post-interview responses also indicated mentors' experiences helping others broadened their understanding of their position and contributions within computing. April shared, "[I can] take a new perspective on computing, not just like being a student who is just producing programs that function, but also one who is helping others and explaining topics and concepts."

VI. Mentoring Competency

Mentors' perceptions of their abilities as mentors can be assessed across various mentoring competencies, such as the ability to communicate with mentees or the ability to assess mentee growth. Understanding mentors' perceptions of their mentoring abilities is key to developing mentoring relationships because these perceptions may positively or adversely affect their interactions with their mentees.

A. Mentoring Competency Assessment Survey Results

We used the Mentoring Competency Assessment (MCA) instrument to examine mentors' perceptions of their mentoring skills. The MCA is a validated 26-item, five construct scale [15]. It uses a 7-point Likert-scale. Constructs include maintaining effective communication, aligning expectations, assessing understanding, fostering independence, and promoting professional development. The results of the Welch's t-test can be seen in Table V. As shown, all but the promoting professional gains construct saw an increase from the pre to post scores; however, none of these construct level gains were statistically significant (p <0.01). Finally, one survey question was statistically significant at the individual item level under the assessing understanding construct (*accurately estimating your mentees' ability to compute*, p <0.25). This item had a one point lower pre-test average compared to the other construct level items (4.45 versus 5.455) and had a larger gain in the post-test responses (0.95 point gain compared to an average of 0.21 for the other construct items).

B. Mentoring Competency Interview Results

In addition to the survey, we qualitatively analyzed mentoring competency beliefs via pre and post interviews with mentors. The interview protocol included questions that aligned with the mentoring competencies assessed by the MCA survey. These questions included, "On a scale of 1-10 with 10 being the most confident, how confident do you feel about your ability to serve as a mentor?" and "How has being a mentor for Rise Up or Sisters Rise Up affected your confidence in your mentoring ability?"

1) Maintaining effective communication: Maintaining effective communication with mentees involves practices such as demonstrating active listening and providing constructive feedback [15]. Due to the pandemic, the majority of the communication between mentors and mentees occurred virtually using tools such as Zoom and GroupMe. The mentors' interview responses reveal that they struggled to maintain

TABLE V: Competency Survey Results

Construct & *Sample Item*	*Pre* (n=11)	*Post* (n=15)	*W*elch's t-test
1. Maintaining Effective Communication. *Providing constructive feedback*	5.73	5.9	0.533
2. Aligning Expectations. *Working with mentees to set learning goals*	5.48	5.57	0.798
3. Assessing Understanding. *Accurately estimating your mentees' level of computing knowledge*	5.12	5.58	0.144
4. Fostering Independence. *Building mentees' confidence*	5.86	5.99	0.759
5. Promoting Professional Development. *Helping your mentees network effectively*	5.62	5.30	0.417

Note: Scale is 1 (not at all skilled) to 7 (extremely skilled); * p <0.05, ** p <0.01, *** p <0.001

effective communication through a fully remote format. Sofia, a Latina mentor, shared

> "My feeling of confidence with communicating went a bit down because of the online nature of how we were tutoring. I can't move, I can't draw on the board all the things that I'm trying to explain."

As the quote reveals, mentors struggled to teach exam content without the conventions of in-person classrooms (i.e moving around, whiteboards). The mentors also reported that they found it difficult to keep the mentees "responsive" throughout the help sessions. Prior research has shown that the most effective near-peer mentoring relationships are collaborative and require the engagement on behalf of both the mentee and mentor [1]. Thus, instances in which mentees did not respond negatively impacted the mentors' competency beliefs.

Despite the struggles, several of the mentors shared in the post-interview that the experience had pushed them to learn more about how to communicate effectively. Mentors reported accommodating "quieter" or "shy" mentees by encouraging the use of the chat feature, leaving their cameras on so mentees could read their facial expressions, and trying to streamline communication through the consistent use of a single app like GroupMe.

2) Aligning expectations: Aligning expectations with mentees involves establishing clear boundaries, setting mentoring goals, and working with mentees to develop learning goals and strategies for achieving those goals [15]. Our analysis of the interview data found that mentors sometimes felt that the mentees didn't meet their expectations. For example, Leah, a white mentor, felt frustration with the lack of participation:

> "We would ask questions and they would just not answer them. We asked, 'What's up? Why aren't you responding to us?' I think a lot of it was just, they had a lot going on and this was not their priority, which is fair."

Although several mentors expressed frustration with the lack of participation, they also felt it may have been due to the pandemic and tried to be understanding.

3) Assessing understanding: Assessing understanding involves accurately estimating your mentees' level of computing knowledge. During the pre-interview, most of the mentors expressed low confidence in their ability to assess mentees' computing knowledge and skills. For instance, Mariah, an African American mentor, shared that she did not feel comfortable assessing "how much or how comfortable a mentee was with a concept" or determining whether or not mentees would be a "little careless with their responses because [they] were not in a super formal school setting." Analysis of post-interview responses found that by the end of the program mentors were able to more clearly and concretely discuss their assessment strategies. For example, Alaina, a white mentor, shared that she learned how to use verbal prompting to assess understanding, "it's helped me to be able to ask them vocally that they understand, instead of assuming that they understand." Alaina also shared that she learned how to "adjust the way I explain things based on how they were responding to it." She paid close attention to how mentees responded to activities and had to "think on [her] toes" to "find other examples" that would help mentees learn. For most of the mentors, learning to assess the mentees' understanding was a process of experimenting with different informal assessment strategies. April shared, I am "more comfortable with figuring out what they're actually asking, what they understand, what they don't, [and] if my explanation is being helpful." These interview findings align with the survey findings which showed a statistically significant increase under the "assessing understanding" construct.

4) Fostering independence: Fostering independence among mentees involves building their confidence by acknowledging positive performances, motivating them to independently accomplish tasks, and acknowledging their ability to participate in computing. During the pre-interviews, mentors expressed a lack of confidence in their ability "to teach someone how to think" or to help others "figure out their own way" of achieving success in computing. The mentors' lack of confidence was evident when reviewing recordings of the virtual help sessions. Mentors often defaulted to lecturing or giving out answers. While not an extensive re-training, the mentors were provided with strategies for avoiding lecturing and making help sessions more interactive. By the end of the program, the mentors did express a sense of growth in their abilities to help mentees "make independent decisions." One mentoring strategy that mentors shared during post-interviews was avoiding the "easy" approach of providing answers. For example, Sophia, a Latina mentor, said: "It's not like they're coming to me like I'm Google, and I just spit out an answer. I'm telling them how to prepare, to know how to code later on, to figure out why it isn't working by themselves." April similarly described not helping the mentees "too much" and stressed teaching them that "trusting themselves" was important for their future education. By the end of the program, April viewed their mentoring role as someone who could help others "walkthrough their thought process" and "establish a framework for thinking through their

problems with computing."

5) Promoting professional development: Promoting professional development among mentees involves helping them learn to network effectively, set career goals, and acquire resources such as scholarships. The post-interview results revealed that the mentors felt unsure about how to balance time spent on professional development with CS exam preparation during the help sessions. Ashley describes continually reevaluating this balance:

> "Maybe they don't want to hear a lecture for that long. Maybe they want to talk about what they want out of their goals. Or maybe they want to hear less about future education and career goals and they want to focus on specific content for the exam. That was always a relationship that we were continuing to reevaluate."

Christina, an Asian mentor, decided to manage her level of "influence" on mentees' career goals and instead foster independent decision-making: "They need to choose to pursue a career in computer science...I could influence them..but I feel like that's another choice they need to make on their own." Similarly, Sarah, an Asian mentor, chose to "never really push" discussions about future education and career goals and viewed her mentoring role as mainly limited to helping them learn the AP CS exam content. The confusion about fostering mentees' professional development uncovered a misunderstanding about the program goals and the need for more in-depth training about mentoring roles.

VII. Culturally Responsive Teaching

Culturally Responsive Pedagogy (CRP) is an asset-based educational approach that values the cultural practices, knowledge, and skills that diverse learners bring into the classroom [14], [18], [19]. CRP encourages educators to shape their instructional practices and forms of assessment in ways that are responsive to students' cultural orientations [20]. These instructional practices can include establishing strong social relationships with students and their families, building classroom environments where cultural differences are respected, valuing different forms of knowledge production, and providing multiple opportunities to demonstrate learning [21]–[23].

A. Culturally Responsive Teaching Survey Results

We measured competency beliefs related to culturally responsive teaching using the Culturally Responsive Teaching Self-Efficacy (CRTSE) and Culturally Responsive Teaching Outcome Expectancy (CRTOE) subscales [23]. Both scales used likert-type items on a scale from 0 (no confidence at all) to 100 (completely confident). The CRTSE scale asks mentors to rate their confidence in their ability to use specific culturally responsive teaching practices, whereas the CRTOE scale asks mentors to rate the probability of success that specific culturally responsive teaching practices will lead to positive outcomes [23]. As seen in Table VI, despite some gain, the sub-scales did not have statistically different means between the pre- and post-tests. Furthermore, no individual item had a statistically significant difference in means.

TABLE VI: Culturally Responsive Teaching (CRT) Survey Results

Construct & *Sample Item*	*Pre* (n=11)	*Post* (n=15)	*W*elch's t-test
1. Self-Efficacy (CRTSE). *Use my mentees' cultural background to help make learning meaningful.*	69.61	75.75	0.320
2. Outcome Expectancy (CRTOE). *Incorporating a variety of teaching methods will help my mentees to be successful.*	84.7	85.29	0.922

Note: Scales are [1,100]; * p <0.05, ** p <0.01, *** p <0.001

B. Culturally Responsive Teaching Interview Results

In addition to the survey, we analyzed pre and post interviews with mentors for competency beliefs related to the following culturally responsive teaching practices: building positive relationships, connecting learning to lived experiences, creating safe learning environments, and supporting critical reflection.

1) Building positive relationships: Building positive relationships with learners involves demonstrating care for mentees' physical and emotional well-being, obtaining information about their home lives, and fostering mutual feelings of trust [19], [23]. Mentors were encouraged to build relationships with their mentees by facilitating icebreaker activities that involved obtaining and sharing information about each others' home lives, families, friends, and interests. However, the mentors often skipped the icebreaker activities and began directly with reviewing exam content. The interviews revealed that several of the mentors found it "awkward" to share personal information in virtual help sessions. These feelings of awkwardness often stemmed from a sense of ambiguity about what role a mentor should play and whether that role more closely aligned with serving as a "teacher" or "friend." For example, Destiny shared:

> "Our personal relationships could have been a bit better. I mean the distance between ourselves in a personal sense. I was such a teacher to them and couldn't even be like a mentor or friend or anything like that. It kind of had us at a distance."

Destiny's response reveals that she struggled to navigate the line between the personal and professional. She used a sense of personal "distance" to delineate between roles such as teacher, mentor, and friend. For her, playing the role of "teacher" served as a barrier to forming a "mentor or friend" relationship with mentees. In contrast, Mariah did not want to be seen as occupying a "a super formal position of power like a teacher." For her, mentoring involved talking to the mentees "as if they were [her] friend" and letting mentees know that she was there "to help them and not just serve as an authority figure." Our analysis of the interviews found that mentors possessed

differing views on the roles and positions of mentors, including conflicting opinions on the forms of relationships they should foster with mentees.

2) Connecting learning to lived experiences: Connecting learning to lived experiences involves valuing mentees' diverse experiences as funds of knowledge [24] that can be leveraged in the learning process. The process first requires an understanding of mentees' intersecting identities (i.e. how their cultural, ethnic, racial, and gender identity categories intersect) and how those identities inform their experiences and worldviews. During the pre-interview, mentors expressed excitement and curiosity about their mentees' experiences. Henry, an Asian mentor, was particularly excited about the "new experience" and explained, "I am international so I will be able to learn their culture as well. How do they feel? How do they think?" However, upon reflecting in the post-interview, Henry found it somewhat difficult to work effectively with mentees whose personal background and experiences were different from his own. Similarly, Sarah shared that she had "never interacted with high school students in America" and struggled to connect with mentees due to language barriers and feelings that they were "not very much fluent in English."

Most of the other mentors found it difficult to connect learning to mentees' cultural backgrounds and felt uncomfortable discussing personal backgrounds. In particular, several of the mentors viewed discussing cultural backgrounds as crossing a professional border. Henry explained:

> "I feel like people's backgrounds weren't really brought up a lot...There's a professional/personal border..between a mentee and a mentor...we kind of kept to our cultural sides, not crossing that line..."

The post-interviews provided mentors an opportunity to reflect on their abilities to connect mentors' experiences and backgrounds to concepts or careers within computing. Although they expressed low competency beliefs, most of the mentors identified culturally responsive teaching as a growth opportunity. Alaina stated, the mentoring experience "forced me to start thinking outside the box in terms of explaining different things and relating different concepts back to cultural differences." Similarly, Mariah expressed that she was "still learning" how to use culturally responsive teaching practices within computing education, but that he walked away with an increased understanding of how important it is to "to be really reflective of the language [he is] using."

3) Creating safe learning environments: Creating a safe learning environment involves supporting the emotional, physical and psychological well-being of mentees. For the mentors in this program, the process of establishing a safe learning environment was disrupted by the pandemic. Ashley expressed concern that the "extremely non-traditional" format caused by the inability to host in-person help sessions would negatively impact the mentees' interest. In response, she tried to exhibit a sense of control to ease her mentees and make them feel safe to continue learning:

> "The experience has taught me a lot about ambiguity. When requirements change, you have to keep being steady even though you're faced with a situation that you weren't expecting. You have to keep trying to keep things steady for the students."

The mentors expressed feelings of stress and anxiety that stemmed from their own attempts to navigate the pandemic and often sympathized with the mentees' inability to focus during virtual help sessions. Mariah tried to combat the stress and anxiety in help sessions by creating a space where failure and frustration was allowed: "It doesn't matter if you got that question wrong, we can talk about it, it doesn't matter what you say because they won't hurt my feelings." Several of the mentors shared that they did not want to add to the mentees' stress levels and therefore did not "force" mentees to participate during help sessions. Unfortunately, the mentors' efforts to avoid stressful interactions with their mentees resulted in help sessions that were often not engaging or interactive.

4) Supporting critical reflection: Critical reflection describes the practice of deliberately contemplating how one's identity and experiences frame personal world views. Mentors and mentees can both benefit from reflecting on their personal motivations and goals, as well as their position within the larger field of computing. The goal of the culturally responsive mentor training was to provide an opportunity for mentors to educate themselves on the issues that contribute to unequal participation in computing and to think critically about their role in addressing those issues. However, the post-interview results revealed that most of the mentors focused on the AP CS exam content and did not spend time facilitating reflective discussions on the participation of underrepresented groups in computing. For example, when reflecting upon her abilities to discuss the contributions of underrepresented groups in computing, Erica stated that "in retrospect" she wished she had shown mentees "people from their culture succeeding in computer science." While mentors did not demonstrate significant growth in their ability to either personally engage in or support mentees' critical reflection on representational disparity in computing, they were able to engage in self-reflection about their own paths into computing. April stated that discussing career goals with mentees led her to reflect on "why I went into computer science, why I enjoy it, [and] why I'm pursuing it as career."

VIII. Discussion

Our long-term goal is to develop a near-peer mentoring model that promotes the academic and professional growth of both mentors and mentees. Looking at the survey results, we notice gains in most survey constructs. However, only the programming self-efficacy surveys had statistically significant gains. Although the mentoring competency and culturally responsive pedagogy surveys did not see statistically significant gains, it is important to note the relatively high pre- and post- test means. The results could speak to mentors' prior experience and awareness of these concepts, where this program served to reinforce prior knowledge as opposed to teach new concepts. The idea that participating in the near-peer mentoring program reinforced prior academic knowledge is

further supported by the interview data, as most of the mentors shared that they built upon their prior programming knowledge and felt that mentoring others solidified their programming self-efficacy beliefs.

In terms of mentors' competency beliefs related to mentoring and culturally responsive teaching, most of the mentors expressed that near-peer mentoring helped them experiment with different strategies. The process of trial and error provided mentors with a more realistic view of the complexity of mentoring, which could also account for the non-statistically significant gains in these survey areas. Nonetheless, the lack of statistically significant gains suggests that mentors will benefit from additional training on mentoring competencies and culturally responsive teaching.

Upon reflecting on the results, we posit that the following factors need to be addressed in our future work.

A. Providing a clear vision of mentorship that aligns with the program values

Mentors expressed a sense of ambiguity about what role a mentor should play and whether that role more closely resembled a "teacher" or "friend." Ambiguity about their roles as mentors resulted in misconceived notions about professional/personal boundaries that prevented them from learning about mentees' lived experiences, cultures, and future life goals. As their interview responses show, the mentors focused their efforts on providing academic support and struggled to relate to the mentees. While prior research [5], [9] has identified relatability as an important factor in near-peer mentoring relationships, our research revealed the importance of considering identity markers beyond age and race, such as differences in educational experiences resulting from receiving schooling in different national and international contexts. Going forward, we plan to provide mentors with a clearer vision of mentoring roles and responsibilities, as well as more extensive training on mentoring competencies and culturally responsive teaching *throughout* the program.

B. Building in opportunities for mentor self-reflection throughout the program

The opportunity to reflect on their mentoring experiences during the post-interview was generative and revealed that these moments of reflection are necessary for internalizing growth and increasing competency beliefs. For example, after the pandemic forced the program to go entirely virtual, mentors described learning "really quickly" that "things that worked before maybe don't work at all in a virtual format." These types of realizations negatively impacted the mentors competency beliefs by causing them to question the effectiveness of their mentoring strategies. Without an opportunity to reflect on how they were working through a difficult situation, many of the mentors internalized difficulties as failures. When given the opportunity to reflect during the post-interview, mentors were able to reframe how they handled mentoring through the pandemic as positive growth in their ability to handle unexpected changes and to deal with ambiguity. In our future work, we will plan in more opportunities for mentors to reflect on their experiences with the research team, as well as the other mentors through guided sessions. We also plan to build in more time for mentors to reflect on the experiences of underrepresented groups in computing and the issues that interfere with their academic and personal growth, such as implicit bias and stereotype threat.

C. Facilitating opportunities for co-assessment of mentoring relationship

Near-peer mentoring relationships change over time; the change may take the form of a strengthening relationship as both parties build rapport and trust, or a weakened relationship as they struggle to communicate and respect each other. These types of changes are difficult to identify without providing mentors and mentees opportunities for feedback and assessment. In our study, the mentors expressed frustration and confusion over mentees' lack of engagement during help sessions. Without a process of co-assessment, it is challenging to ascertain what was causing the mentees' lack of engagement. In our future work, we plan to provide mentors and mentees opportunities to assess their relationship and provide feedback to each other. We hope that the process of co-assessment as a mentoring relationship develops will foster open dialogue that will improve the experiences of both parties.

IX. Conclusion

Low competency beliefs negatively impact mentor-mentee interactions and have a detrimental impact on mentees' interest and academic outcomes, as well as mentors' own interest in supporting others. Given the importance of mentor competency beliefs, we conducted a mixed-method study to examine how near-peer mentoring experiences impact mentors' competency beliefs related to programming, mentoring, and culturally responsive teaching. Our findings align with prior research [1], [6] demonstrating that near-peer relationships have positive academic outcomes for mentors and mentees. The mentors in our program reported that serving as a near-peer mentor reinforced their prior programming knowledge and increased their programming self-efficacy. Perhaps more importantly, our study contributes a reflective account of the complexity of designing a program that effectively improves academic outcomes *and* successfully trains mentors to critically reflect on their role in promoting more equitable educational opportunities within computing. Training mentors to create supportive learning environments requires continued training opportunities and clear program messaging that goes beyond privileging academic outcomes and stresses the importance of social and cultural outcomes for mentors and mentees. We plan to use this information to improve our mentor training and further develop a mutually beneficial near-peer mentoring model for computing education that intentionally supports and assesses the development of mentors.

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