



Coaching Teachers to Teach Computer Science with Equity-focused Teacher Standards

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ABSTRACT

Problem. Currently, state- and district-level policies in the United States call for teachers to be qualified to teach computing in K-12 classrooms. Recognizing that equity-focused practices are key to reaching all students in computing and leveraging a researcher-practitioner partnership (RPP), we piloted an intervention designed to provide one-on-one coaching to teachers.

Research Question. Our research questions for this project were: 1) *What impact does CS coaching have on teacher capacity to implement equitable teaching practices?* and 2) *What, if any, changes to teacher practice are sustained during and after the CS coaching process?*

Methodology. Our mixed-methods study leveraged three primary forms of data from teachers who were coached (coachees) and teachers providing coaching (coaches). These included pre- and post-surveys, coaching logs, and self-reflection checklists.

Findings. Participants reported use of high-impact instructional design and classroom practices increased significantly from pre- to post-intervention. Their abilities to discuss topics of identity and plan activities that use evidence-based, CS-specific teaching strategies saw the most dramatic increase from pre- to post-intervention.

Implications. Coaching may be an impactful way to develop teacher's use of equitable teaching practices.

CCS CONCEPTS

• **Social and professional topics** → **Computing education; Computing education programs; Computer science education.**



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KEYWORDS

standards for teachers, CSTA, coaching, mentoring, high school teachers, computer science

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1 INTRODUCTION

Equity is threaded throughout the Computer Science Teachers Association's (CSTA) Standards for Computer Science (CS) Teachers [12], both as a standard itself (Standard 2. Equity & Inclusion) as well as throughout indicators in each of the other standards. In the United States, 43 states have certification requirements for CS [9], teachers may become licensed through a primarily content-focused exam (e.g., Praxis CS) or a graduate endorsement program with a CS methods course [29]. State guidelines of what teachers need to know are often aligned to the state's student standards for CS, specifying concepts and practices rather than equitable and inclusive pedagogies. However, many CS teachers only receive initial professional development (PD) aligned to a particular curriculum, with limited opportunities for advanced PD focused specifically on equity and pedagogy.

Coaching is a promising model for addressing equity in the CS classroom. Coaching as a form of PD is designed specifically to meet the individual needs of teachers, with a coach who can provide a critical friend perspective through observations, examining lessons and student artifacts, and reflective conversations. While coaching is available in many districts, few have coaches with CS expertise. With most CS teachers being the only one in their district, until CS efforts scale more widely, remote coaching may bridge this gap.

The use of cognitive coaching has also been successful in supporting education faculty in integrating CS concepts in teacher preparation programs [33]. Israel et al. found that coaching models that included co-planning and co-teaching components played an integral role in supporting CS teachers in meeting the needs of

diverse learners, including students with disabilities [18]. Coaching, therefore, is a critical component of effective professional learning with potential for clear impact on students, especially those historically marginalized in computing.

Coaching and teacher PD falls within capacity building within the CAPE framework [14], a framework that defines equitable capacity, access, participation and experiences across the education ecosystem, and holds a close relationship to state and district-level policy initiatives. Policy can drive the need for more teacher PD through requiring licensure and credentials for teaching CS as well as simply meeting the need to teach a required set of students such as all high school students. Policy can also be linked to accountability, and measures related to student outcomes are often put into place to ensure policies are implemented and are impactful. Given this relationship to student outcomes, our research questions for this study were:

RQ1: *What impact does CS coaching have on teacher capacity to implement equitable teaching practices?*

RQ2: *What, if any, changes to teacher practice are sustained during and after the CS coaching process?*

The primary purpose of this study was to examine the impact of coaching on high school teachers and their use of inclusive teaching practices in CS courses. This project leveraged a research-practice partnership (RPP) to ensure that practitioners and researchers contributed to the process of studying and improving the pilot study.

2 BACKGROUND

2.1 CS Teacher Practice & Policy

In a national survey, CS teachers report actively working to create inclusive learning environments for their students; however, about one-third are not comfortable with using identity-inclusive practices in their classrooms [19]. For example, the study found that 33% of CS teachers are not confident using culturally relevant pedagogy and 27% are not confident teaching students with disabilities. Even more striking, 31% do not believe that racism, sexism, ableism, and other systemic issues of inequality should be discussed in the CS classroom and 60% do not teach impacts of computing, one of the core concepts in the CSTA K-12 Standards for Students. The *Scaling Inclusive Pedagogy* course [25] and CSTA's course, *Identity Inclusion for CS Educators*, are examples of PD opportunities for CS teachers specifically focused on equity. Policy briefs from the Expanding Computing Education Pathways (ECEP) Alliance on teacher qualification pathways and pre-service programs also call attention to consider how accessible pathways and programs are for teachers from marginalized backgrounds [2, 29]. In the United States, diversifying CS teacher education workforce is important both because it does not currently reflect student demographics [19] and more CS teachers are needed overall [8].

2.2 Marginalized Students in CS

While there are many groups historically marginalized in computing, three populations of students that have significant numbers in the U.S. general student population are female students, students with disabilities, and English learners. Students receiving special

education services, or students with disabilities, were 14% of public school students in 2018 [35]; English learners were 9.6% of the student population in public schools in 2016 [28]; and female students were 55.6% of all students in 2016. While these numbers are indicative of overall school demographics, these students are less likely to be in CS courses (13% - students with an individualized education program (IEP) or 504 plan, 6% - English learners, 31% - female students) [10]. Best practices for supporting these students in the classroom are summarized next.

2.2.1 Students with Disabilities. While some students with disabilities have IEP or 504 plans, others may not have been diagnosed yet or do not have formal plans in place. Both sets of students can benefit from addressing their needs in the classroom and support should address three key challenges: 1) teacher attitudes and expectations, 2) pedagogical approaches, and 3) accommodations and accessible materials [21]. Universal Design for Learning (UDL) principles are widely used in general education to support students with learning disabilities and have also been applied in CS settings with some specific adaptations [5, 17, 39]. Outlier Research's Access CSP materials [13] include teacher-focused materials on both whole classroom adaptations using UDL principles and specific accommodations for students with learning disabilities and attention disorders. Both AccessCSforAll and Outlier provide stories from students about their experiences in CS courses that can be used as discussion points in PD and coaching conversations. The UDL4CS project [20] has also generated a wealth of resources and recommendations on applying UDL principles to CS learning experiences.

2.2.2 Female Students. Syntheses of research on supporting female students in STEM and CS have been shared through frameworks including the SciGirls Strategies [34], used to increase interest and attitudes in middle school girls programs, and the National Center for Women and Information Technology's (NCWIT) Engagement Practices Framework [27], used in undergraduate computing programs. Common themes across frameworks include making connections to student interests and prior experiences, using a growth mindset to instill a belief that intelligence develops with effort, providing collaboration opportunities such as pair programming, mitigating stereotype threat, and including role models. A systematic literature review reveals that there has been more research on and evidence for the use of "Grow an Inclusive Community" and "Make it Matter" practices from NCWIT's framework than the third practice, "Build Student Confidence and Professional Identity" [26].

2.2.3 English Learners (ELs). As students are learning English, they need to use it in both social and academic contexts [41]. Social language refers to vocabulary and sentences for everyday conversation while academic language refers to the vocabulary, grammar, and organization used within the context of learning a subject. Academic vocabulary may categorize words as brick or mortar terms; examples of brick words in CS include algorithm and debugging while mortar terms includes if, then, else, while which are common in social language but have a specific meaning within the context of CS. Strategies for supporting ELs in CS include providing explicit opportunities to engage with language while learning it (input) and while students share their learning (output) and providing scaffolding such as word walls with images and text, sentence starters,

and multiple low-stakes opportunities for oral communication [36]. Translanguaging theorizes that students draw on all their languages and cultures during learning and that providing opportunities for students to express themselves in multiple languages and move between them facilitates the learning process [37].

2.3 Coaching for Equity

Classroom equity issues persist when teachers lack the knowledge and experience required to provide robust learning opportunities to learners from historically marginalized backgrounds. Thus, we relied on a Coaching for Equity model to support coaches' work with historically marginalized learners in their CS classrooms. Coaching for equity means seeing inequities and knowing what to do about them, while supporting another educator to develop systems for noticing beliefs and practices that promote or detract from equitable ways of teaching. The coaching program infuses inquiry practices that support culturally sustaining innovations in CS classrooms. Culturally sustaining innovations center the importance of culturally relevant pedagogies with the necessity to be creative in pursuits to develop the pedagogical skills required to be effective with historically marginalized groups like racial minorities, female and gender non-binary, and students with learning disabilities [30].

In this project we sent a call for experienced CS educators who engage in equitable, culturally responsive teaching practices. After pairing these experienced educators (coaches) with less experienced educators of CS (coachees), we trained the coaches on a Coaching for Equity model. The model centers on the wisdom of scholar Elena Aguilar and her work in *Coaching for Equity: Conversations that Change Practice*. Following a thorough reflection of this work, we conducted monthly conversations with the coaches, including role-play and discussions of strategies that are working with historically marginalized learners in their CS classrooms. These conversations revealed significant barriers to teaching these students effectively, barriers to student and teacher efficacy, and opportunities to practice asset-based perspectives and feedback [1].

2.4 Remote Coaching

One challenge to coaching teachers in CS is the relative isolation of these teachers [40]. Online communities have helped to address isolation, providing a professional learning community whether it is through a CSTA chapter or as part of a PD [15, 32]. Using online tools can be effective in coaching as well and may address some of the barriers to scaling CS coaching programs [24]. Teachers can record video of their classroom instruction, allowing both the teacher and coach to review and reflect as part of the feedback process—a process that has been shown to help teachers develop their critical thinking, pedagogical skills, and thoughtful reflections, thereby improving teachers' practice [4, 7]. This model has been used with both in-person and virtual coaching [16, 38] as well in online PD [22] to create a culture of reflection on teaching practices.

3 POSITIONALITY

The positionality of the authors of this paper can be best described as having a social justice orientation with the goal of supporting equity-mindsets among CS practitioners. The authors include five researchers who self-identify as advocates for educational equity

within and across CS classrooms. Therefore, the goals of our research inquiry centers equity in an overall pursuit of educational justice. We recognize the systematic harm experienced by minoritized learners in all classrooms, with a focus on the work necessary for equitable practices in CS classrooms. This orientation is grounded in a worldview that all children can learn, and this learning is likely to occur when educators enact authentic variations of their own culturally sustaining pedagogies [30].

4 METHODOLOGY

To answer our research questions, *What impact does CS coaching have on teacher capacity to implement equitable teaching practices?* and *What, if any, changes to teacher practice are sustained during and after the CS coaching process?*, we engaged in a mixed-methods study. We used CSTA's self-reflection checklists aligned to the teacher standards and created a survey that was given pre- and post-intervention. We also created logs for coaches to record their observations, reflections, and their lesson plans tailored to each of their coachees. In this section, we describe the intervention, the participants, and the methods for data collection and analysis.

4.1 Intervention

Our remote coaching program was led by two U.S.-based organizations, a non-profit in a midwestern state (CodeSavvy) and a national higher education curriculum and PD provider (College of St. Scholastica's National Center for CS Education (NCCSE)). The project linked educators from two groups: high school CS educators teaching a variety of CS courses in a single state and Organization B's Advanced Placement CS teachers (including both AP CS Principles and CS A) from multiple states.

Best practices for the three focal populations (students with disabilities, English learners, and female students) were reviewed and synthesized for inclusion in the coach PD and on <http://www.inclusivecsteaching.org/> for access by coaches and coachees. It is important to note that while the coaching program targeted these three groups in particular, the practices also enhance CS teaching and learning for other groups marginalized in CS.

Before the school year, participating coaches engaged in 25 hours of intensive summer PD. In addition to best practices for the focal populations, this training utilized the CSTA Coaching Toolkit and related materials [23], Cornell Tech coaching cards [31], and the book, *Coaching for Equity* [1]. This immersive program equipped coaches with essential skills in key areas:

- Coaching Methodology: Mastering the fundamentals of the coaching process for effective guidance and support.
- Equity in Education: Implementing strategies to foster fair and inclusive learning environments for all students.
- Targeted Student Needs: Gaining comprehensive understanding of the specific strengths and challenges faced by student populations in both program groups.

The coaching program kicked off with a virtual relationship-building meeting in the fall. This session helped coaches and their coachees get to know each other, set shared goals for the year, and select a focal population (females, students with disabilities, or English learners) for focused equity examination in their classroom.

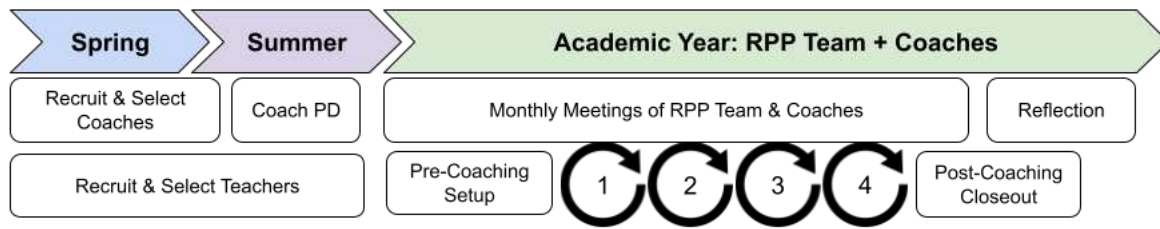


Figure 1: CS Coaching for Equity Program Timeline

Initial meetings between the coach and coachee included additional relationship building activities, reviewing the CSTA self-reflection checklists to set a goal for the year, and learning more about the coachee's school and student context. Throughout the year, most coaches and coachees engaged in 3-4 coaching cycles. Each cycle followed a structured format:

- **Planning:** Examining a specific lesson and adapting it to support the coachee's year-long goal. "Just-in-time" PD was provided by coaches as needed to clarify CS concepts.
- **Implementation:** The coachee recorded their classroom lesson for asynchronous review by the coach.
- **Reflection:** Both parties met to discuss the recorded lesson, analyze the effectiveness of adaptations, and evaluate progress towards the goal.

The program concluded with a post-coaching meeting at the end of the school year. This final session served as an opportunity to reflect on the year's achievements and set aspirations for the future. A shared coaching log document was used to guide the pre- and post-coaching meetings and each of the coaching cycles. Coaches recorded notes in the log of each meeting. An overview of the program timeline is provided in Figure 1.

4.2 Participants

To recruit coaches, we crafted a position description and shared it within the networks of both CodeSavvy and NCCSE. The description included required qualifications of secondary CS teaching, previous experience working with peers (facilitating PD, mentoring, coaching, etc.), demonstrated implementation of best practices to support learners from all backgrounds, a commitment to equity, and a desire to support adult learners. Coach applications were evaluated with a rubric aligned to the position description and selected based on three key criteria: CS Teaching Expertise (proven experience in leading high school CS courses), Adult Learner Focus (demonstrated understanding and commitment to effectively supporting adult learners' development), and Equity Inclusiveness (prior experience in advocating and empowering students underrepresented in computing fields). Twelve coaches were selected for the coaching program, six in each organization.

To recruit coachees, we sent the opportunity through existing networks of teachers in one Midwestern state who had previously participated in professional development (PD) programs offered by both organizations. Additionally, we used social media and email listservs to reach potential participants. Out of the 20 coachees selected for the program, 16 completed both pre- and post-surveys.

Among these, seven identified as women and nine as men. Most coachees identified as White, with one identifying as Hispanic. Four coachees (25%) reported having a disability.

While their CS experience varied, most coachees had substantial teaching experience (over 8 years). Most held licenses in math, CS, science, or business, with a few possessing special education and English as a second language licenses. Further, their CS backgrounds were diverse, ranging from individuals with industry experience to those with no formal CS coursework, alongside those who had taken some CS classes. Coaches and their teachers (coachees) were carefully matched based on shared experiences. Both programs considered similar course or curriculum expertise as a primary pairing factor. Additionally, teachers in the program benefited from geographically close matches with their coaches.

4.3 Data Collection & Analysis

Coachees completed self-reflection checklists aligned to the CSTA Standards for CS Teachers and a survey before and at the end of the coaching program. During the program, coaching conversations were tracked in coaching logs.

4.3.1 Self-Reflection Checklists. We conducted *dependent-samples t-tests* to analyze coachees' self-reflection checklists. This approach allowed us to compare their self-reported computer science (CS) knowledge and skills before and after participating in the program.

4.3.2 Coaching Logs. Coaching logs included observation notes, reflections from both the coach and coachee, and coachee lesson plans as well as pre-coach set-up logs, coaching cycles 1-4 logs, and post-coaching closeout logs. We conducted a content analysis of the logs and themes arose. To support the themes in the results section, we include specific quotes.

4.3.3 Pre and Post Survey Analysis. Given the multiple-choice selections and open-ended nature of the pre- and post-survey analyses, we used a combined quantitative and qualitative approach for survey data analysis. The ordinal data underwent scrutiny through a paired t-test, facilitating a comparison between pre- and post-survey responses for coachees who completed both assessments.

For the open-ended responses, we conducted a thematic analysis, focusing on questions pertaining to equity, coachees' classroom practices, and student identity. A grounded theory approach guided the development of codes derived from raw data responses and aligned with the objectives of our research inquiry [11]. Subsequently, we organized each code based on conceptual and practical similarities, directly addressing dynamics inherent in our research

questions. We also created codes to distinguish between potential barriers and support mechanisms for implementing equity. Additional codes were created to discern behaviors or mindsets associated with both teachers and students.

5 RESULTS

5.1 RQ1: Impacts on Equitable Practices

5.1.1 Self-reflection Checklist. Participants rated their equity and inclusion practices on the pre-checklist, on average, as “Developing” ($M = 2.14$, $SD = 0.62$), while on the post-checklist they rated their equity and inclusion practices as “Competent” ($M = 3.20$, $SD = 0.59$). Thus, participants increased from pre- to post-checklist by an average of 1.06 points (on the five-point scale), and this difference was statistically significant and had a large effect ($t(15) = 5.65$, $p < .001$, 95% CI [0.66, 1.45], $Cohen's d = 1.41$). Figure 2 shows the average level of competence participants indicated for their Standard 2 Equity and Inclusion practices at pre- and post-checklist. The blue bidirectional arrows represent scores between scale anchors (e.g., 1.5).

5.1.2 Coaching Logs. Analysis of the coaching logs showed that multiple coaches made suggestions to their coachees to help them individualize instruction and focus on the selected focal group. Comments such as “More personal attention/scaffolding for ELL students” and “thinking about the font size on the slides” as well as intentional pairing of students based on academic needs were suggested by coaches. Reflective questions asked were, “How many [of your] students are girls? How many students are English learners?... Why do you think the other students didn’t [make a video]? How many of the students are [from racial/ethnic underrepresented groups]?”, “How are groups created? How are the students with disabilities partnered? Do you think the students’ understanding of the concepts became clearer when they were able to express their understanding in different ways?”

Coaches provided suggestions for modifying or extending learning experiences to make them more culturally relevant. One coach documented, “in discussing how to use this lesson for equity, we discussed how some cultures are not in base 10.” Another coach and participant had “conversations around identity...this activity was aimed to provide students a platform to learn about issues surrounding identity so they could share their identity.” Also, coaches were able to address potential biases or teaching practices for further reflection by participants. One coach observed that, “Female students’ presentations were over 50% shorter.” Another coach noted “There are a lot [of] quiet girls...although [participant] doesn’t think that’s true. [Students] are less likely to respond to questions, are quiet and reserved. Regardless of who is answering the question.”

The coaching logs provided evidence of action of the progress centered on the focal group. One coach guided their coachee to use data to better assess “whether EL students felt like they belonged in the class...” by introducing an exit poll. A different coach assisted their participant to “gather background information on CS perspectives from female students.” Then the findings were presented to the school counselors and “alterations to CS offerings are now being discussed for the 24-25 school year that would ease the scheduling constraint mentioned on the survey.”

Not all of the coaching logs or observations provided documentation of support or scaffolding for the focal population. Two of the coaches mentioned the focal group in the coaching log, but there was little to no evidence of coaches providing feedback on implementing equitable teaching practices related to the focal group. The comments about girls, including “many are not in class...this is a recruiting issue that will and can be better addressed going into year 2” and “the focal group was “engaged, but mostly engaged with their already established friends” were both observations related to the focal group but did not provide support to the participants on addressing practices and reflecting on how to better meet the needs of the focal group.

Additionally, a different coach provided little to no feedback or guidance to the participant related to the focal group even though the participant was implementing equitable teaching practices. The participant shared, “one young lady of color has been having lots of confusion, so meeting with her on Google Meet multiple times to help and build the relationship and getting her the extra help she needs.” The coach’s feedback generally was connected to CS or participant’s instructional practices, such as “Opportunities for improvement: clearer directions on some assignments and better reflections to get the students to think deeper.”

Coaches also provided feedback to support the participants that was beneficial to creating equitable classroom environments even if it was not specific to the focal group. For example, “Excellent intro [to] the project. Considering equity, it’s really important to consider how you present work to students, and you did an excellent job of that by introducing the overall objective, providing a visual and telling the students you’ll break down the steps” and “Visiting with all students, Less time providing instructions → more time to meet and differentiate” is one way “we equitably amplify student voices during independent work.”

5.1.3 Survey Data. Participants rated their attitudes on nine items about equitable teaching practices from 1 (Strongly disagree) to 5 (Strongly agree). The items were treated as a single Equity Attitudes Scale and showed adequate reliability at both pre-survey ($\alpha = .79$) and post-survey ($\alpha = .75$). For clarity, the nine items that comprise the scale are described below:

1. I feel confident in teaching CS using curricular materials that highlight race, ethnicity, and culture.
2. It is important to allow for student choice when designing CS learning activities.
3. Issues related to racism, sexism, and other inequities should be openly discussed in CS classrooms.
4. Effective CS teaching incorporates diverse cultures and experiences into classroom lessons and discussions.
5. Connecting my students’ prior knowledge with CS concepts will lead to deeper learning.
6. Providing opportunities for my students’ to express their identities while learning CS will lead to increased student engagement.
7. Incorporating a variety of teaching methods in CS will help my students be successful.
8. I feel confident in using instructional materials that are accessible for all students.

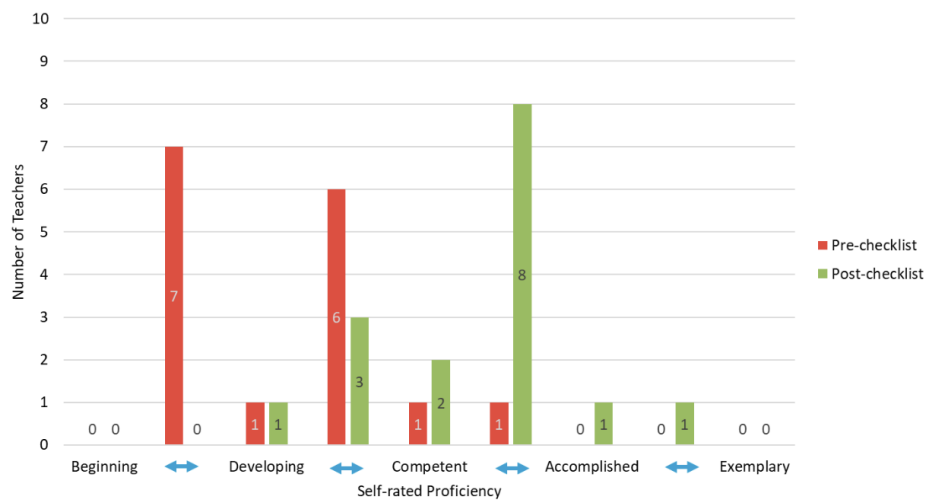


Figure 2: Participants' Ratings of their Equity and Inclusion Practices.

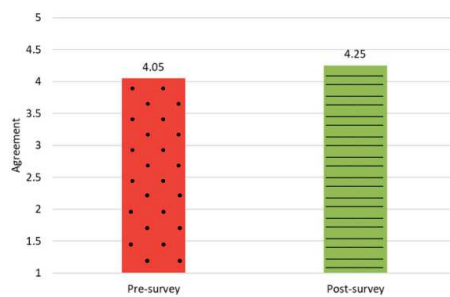


Figure 3: Participants' attitudes of equitable teaching practices.

9. I regularly reflect on how issues of equity impact my CS teaching practice.

A one-tailed paired-samples t-test revealed a statistically-significant increase from pre- ($M = 4.05$, $SD = 0.42$) to post-survey ($M = 4.25$, $SD = 0.35$) by an average of 0.20 points on a five-point scale (see Figure 3), and this difference was statistically significant with a medium effect size ($t(15) = 2.16$, $p = .03$, $Cohen's d = 0.53$). On average, participants rated their attitudes toward equitable teaching practices as "Agree" prior to intervention, but that sentiment moved toward "Strongly Agree" after the intervention (see Figure 4).

5.2 RQ2: Sustained Practices

5.2.1 Self-reflection Checklist. Participants rated their instructional design practices on the pre-checklist, on average, as "Developing" ($M = 2.29$, $SD = 0.73$), while on the post-checklist they rated their instructional design practices as "Competent" ($M = 3.15$, $SD = 0.72$). Thus, participants increased from pre- to post-checklist by an average of 0.86 points (on the five-point scale), and this difference was statistically significant and had a large effect ($t(15) = 5.69$, $p < .001$, 95% CI [0.54, 1.18], $Cohen's d = 1.42$).

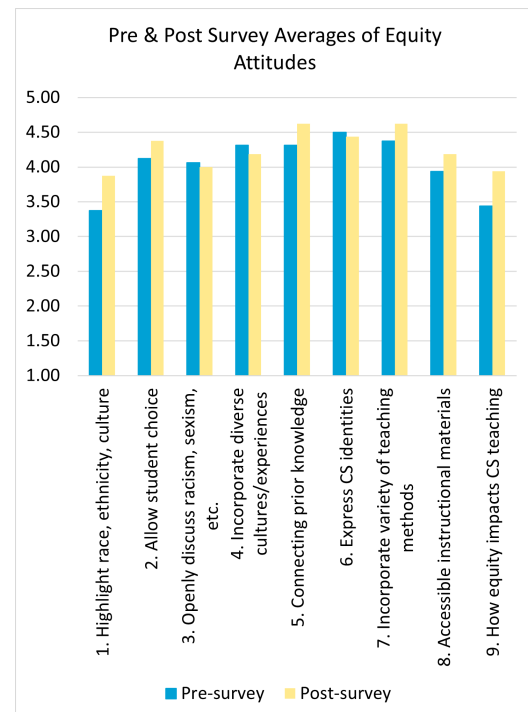


Figure 4: Participants' changes in attitude.

Participants rated their classroom practices on the pre-checklist, on average, as nearly "Competent" ($M = 2.86$, $SD = 0.66$), while on the post-checklist they rated their classroom practices between "Competent" and "Accomplished" ($M = 3.55$, $SD = 0.67$). Thus, participants increased from pre- to post-checklist by an average of 0.69 points (on the five-point scale), and this difference was statistically significant and had a large effect ($t(15) = 4.64$, $p < .001$, 95% CI [0.37, 1.00], $Cohen's d = 1.16$).

5.2.2 Coaching Logs. Instructional Delivery. Various participants made changes to their instructional delivery during the coaching cycle. Evidence of the changes in teaching practices were present when looking at sequential collection of information found in the coaching cycle and on the post-coaching closeout documentation. One coach described their participant as “changing from the sage on the stage to a more student-centered model where collaboration was the key.” Through observations, some coaches provided participants feedback regarding the delivery of instructions. For example, “video and written instructions provided more clarity for students, especially focal students”, “Improving online communication with students”, and “Opportunities for improvement: clearer directions on some assignments and better reflections to get the students to think deeper” were some of the feedback given to participants.

Several participants implemented the feedback to create a more inclusive learning environment. One participant increased their use of inquiry-based learning to enhance student understanding of CS content. In one observation, the coach documented the participant “repeated student thoughts and asked questions to deepen levels of thought.” A different participant “discussed structuring the inquiry through more formalized questioning such as the PRIMM method” with their coach. During an observation, the coach and participant “discussed giving students more opportunity to explain their thinking.” At the post-coaching closeout, the highlight of participant’s CS teaching improvements was “willing to engage when she tried new instructional strategies to support inquiry-based learning.”

A coach applauded a participant’s ability to use scaffolding to support their students. They stated, “It’s good that the students have choice within the project and the support/ starter code and other scaffolding for their work.” Another participant, who focused on tailoring “project requirements to meet students’ needs...” listed “scaffolding and working to add in instructional strategies and activities to help build towards more complex content [and] make the content more accessible for all students” as a change to her teaching practice that she intends to use next year.

Student Collaboration. Many changes to the participant’s classroom practices were documented throughout the coaching logs, particularly at each coaching cycle and as the post coaching closeout reflections. A major teaching practice change for many of the participants was increasing their use of student collaboration, specifically through pair programming or small groups. At the beginning of the coaching cycle, most of the participants were already using some form of student collaboration. For example, participants required their students to “make an analogy and post it somewhere... students reply to each other” or “justify their reasoning when they figured out the solution to their peers.”

Several coaches helped their participants be more intentional about pair programming. Through observations, coaches provided feedback on additional opportunities for participants to increase student collaboration such as, “engage students to share their work, with lower stakes (e.g., gallery walk, share-pair.” Additionally, the coaching logs documented conversations about pair programming between coach and participant. One coach and participant team established their to-do as “learn more about strong-style pair programming.” Some coaches suggested participants use pair programming to address problems in the class. For example, to address the students’ reluctance at pseudo coding, and their desire to get on the

computers, the coach “suggested that he use white boards and have the kids work in pairs out in the hallway away from the computers. When they displayed a well thought out pseudocode, they could come back in.” The participant tried it and “the pair programming worked amazingly well. Students were very engaged in the lesson, talking to each other a great deal without getting side-tracked.”

Other participants were willing to try suggested techniques to enhance student collaboration. For example, one participant was willing to “try out Class Dojo” and another stated they will be using “Collaborative Techniques” in the summer to think about collaboration. One coach suggested, “...splitting the students up to scaffold with those who need it.” The participant tried it and it was documented that “the students seemed more engaged with pair programming, but also got off-task more quickly.” The idea of reflecting on the effectiveness of the pairing and repairing the students as needed was discussed by coaches and participants throughout their coaching cycle. One coach reflected, “We would think a bit more about the pairings on an individual level. Apart from organizing by ability in general, [participant’s name] felt that he could have done a better job separating those who needed it...” Another coach noted their participant’s progress of “good work changing up modality... from pairs to large groups.”

Participants’ reflections at the post-coaching closeout meeting describe their growth and desire to continue to use pair programming in their teaching practices. Statements such as, “It was extremely eye opening and enlightening to practice some different pedagogy in our CS classroom. I learned so much about collaboration, student self-reflection, paired programming, and student paced learning” and “[participant] uses an excellent well thought out grouping system for students to assess student work and come to consensus” all speak to the participants’ growth towards using practices to support student collaboration. Other participants listed, “Increased use of group discussion to come up with the best answer” and “continue to create opportunities for students to work together” as changes to teaching practices they intend to use next year.

Survey Data. Participants rated their use of high-impact equity and inclusion practices on the pre-and post-surveys as Not attempted or Never, A few times a year, Monthly, Weekly, or Daily. Scale items included:

1. Use inquiry-based learning strategies
2. Use culturally relevant pedagogy to support student learning
3. Adapt lessons to meet the needs of students from diverse backgrounds
4. Adapt lessons to meet the needs of students with disabilities
5. Use a variety of assessment strategies
6. Facilitate conversation about computing impacts on society
7. Make connections between CS and other disciplines
8. Plan projects that have personal meaning to students
9. Use well-structured student collaboration strategies (e.g. Pair Programming, POGIL)
10. Cultivate a classroom climate that values varied perspectives, approaches, and solutions
11. Promote student belief in their ability to do computing (self-efficacy)
12. Provide a variety of opportunities for students to communicate about computing

13. Adjust instruction based on student assessment data
14. Use strategies to challenge implicit bias and minimize stereotype threat in CS
15. Discuss topics of identity (including forms of discrimination and oppression) in computing
16. Plan activities that use evidence-based, CS-specific teaching strategies

This measure showed strong reliability at both pre- ($\alpha = .89$) and post-survey ($\alpha = .88$). Results from a one-tailed paired samples t-test showed a statistically-significant increase in participants' reported use of high-impact instructional design/classroom practices ($M_{diff}=0.36$, $SD = 0.53$) $t(15) = 2.71$, $p = .01$). That is, on average, participants rated their use of high-impact pedagogical strategies as "Monthly" before the intervention ($M = 3.49$, $SD = 0.66$), but after intervention that average rating approached the "Weekly" value ($M=3.86$, $SD = 0.53$). This difference was statistically significant and had a medium effect ($t(15) = 2.71$, $p = .01$, $Cohen'sd = 0.68$).

6 DISCUSSION

6.1 RQ1: Impacts on Equitable Practices

Most participants rated their equity and inclusion practices as Beginning or Developing before coaching and as Competent after coaching. The average difference between pre- and post-intervention indicated a large effect. This aligns with previous research that indicates that peer coaching focused on equity positively impacts educators [3, 6]. In particular, coaching in a remote context using video reflection shows evidence of improving teachers' equity and inclusion practices as found in previous research [24].

Multiple coaches provided feedback and support to participants regarding meeting the needs of their particular focal student population. Some coaches gave suggestions for modifying or extending learning experiences to make them more culturally relevant and addressed potential biases or teaching practices that participants needed to further reflect on. Multiple coaches' stressed how the participant was currently using appropriate practices and creating an equitable classroom environment.

Overall, coachees' equity attitudes changed significantly between pre- and post-intervention. Items 1 and 9 show the most change, which was double in magnitude compared to the next closest items. Although items 3, 4, and 6 all indicated a slight decrease from pre to post intervention, these three items were all endorsed very highly at pre-survey to begin with. Thus, despite the slight decrease from pre- to post-intervention, coachees still largely agreed with these statements after intervention. It may indicate that the program is having little to negative impact on the coachees or that the coaching intervention is attracting coachees that already 1) understand enacting equity entails providing opportunities for students' to express their identities while learning CS; 2) believe it is important to allow for student choice when designing CS learning activities; or 3) understand that enacting equity entails incorporating a variety of teaching methods in CS will help students be successful, along with sustaining this understanding.

When adjusting instruction based on student assessment data, it may be the case that coachees understand students' data differently and may need to engage the data based on how they understand the use of data to inform their instruction. It is plausible that those who

do not see themselves as using this practice on a daily or weekly basis, may only think of formal assessments when asked about student data. Item 3 ("Adapt lessons to meet the needs of students from diverse backgrounds") could be more of a reflection of the demographics of the students that coachees serve, rather than a reflection of their ability or interest in adapting lessons for students from diverse backgrounds. Some educators may not feel like they need to be aware of cultural differences if they share their ethnicity or cultural identity with their students.

Generally, the survey results indicate that the program is likely exposing participants to inquiry-based strategies and they are aware of how and/or the extent to which they use inquiry-based strategies. The program seems to recruit educators that value multiple perspectives and likely supports sustaining the idea that highlighting multiple perspectives is important to effective teaching. The coaching program may be helpful in, at least, helping participants understand that they need to address implicit bias and how to do it. Even if they haven't started doing this, the program may still be useful for spreading knowledge and advocating for high-impact pedagogical practices in CS classrooms.

Synthesizing these, the major findings aligned with RQ1 are:

- **Equity and Inclusion Practices.** Most participants self-rated their equity and inclusion practices as Beginning or Developing prior to intervention, then as Competent after.
- **Equity Attitudes.** Overall, participants' equity attitudes changed significantly between pre- and post-intervention.
- **Coach Engagement.** Multiple coaches stressed how the coachee was currently using appropriate practices and creating an equitable classroom environment. Multiple coaches provided feedback and support to participants regarding meeting the needs of the focal student population.

6.2 RQ2: Sustained Practices

Participants' self-ratings of their instructional design practices (Standard 4) increased after the intervention, and the difference indicated a large effect. Their self-ratings of their classroom practices (Standard 5) also increased after the intervention, with the difference indicating a large effect.

Overall, coaches offered participants guidance to improve their instructional delivery. Several participants implemented the feedback and some increased their use of inquiry based learning and scaffolding. Many of the participants increased their use of student collaboration, specifically through pair programming or small groups. Participants also desired to continue to use pair programming in their teaching practices.

Survey items 15 and 16 (participant's abilities to discuss topics of identity and plan activities that use evidence-based, CS-specific teaching strategies) had the most dramatic increase from pre- to post-intervention. Items 4, 5, and 13 saw a slight drop from pre to post-intervention. This may have occurred if participants' conceptions of these practices changed after having gone through the intervention. It could be that after intervention, participants determined that they in fact did not engage these practices quite as much as they originally thought. Item 13 (Adjust instruction based on student assessment data) may indicate that participants understand students' data differently and may need to engage the data

to inform their instruction. It is plausible that those who do not see themselves as using this practice on a daily or weekly basis may only think of formal assessments when asked about student data.

Item 3 (Adapt lessons to meet the needs of students from diverse backgrounds) could be more of a reflection of the demographics of the students that different participants serve, rather than a reflection of their ability or interest in adapting lessons for students from diverse backgrounds. Meeting the needs of students with disabilities may also be conflated with data on meeting the needs of racially/ethnically diverse learners.

A central component to high-impact equity and inclusion practices are classrooms intended to develop students' socio-political awareness, and conversations on the impacts of computing on society are a great way to engage students in raising their awareness. Further, developing projects that have personal meaning to students is a key component of sustained student engagement and culturally relevant and sustaining approaches. Promoting students' sense of efficacy stems from an overall belief within the participants on whether or not they actually see students as having the ability to engage CS. Lastly, some participants may not feel like they need to be aware of cultural differences if they share their ethnicity or cultural identity with their students.

Synthesizing these, the major findings aligned with RQ2 are:

- Participant's reported use of high-impact instructional design and classroom practices increased significantly from pre- to post-intervention. Participant's abilities to 1) discuss topics of identity and 2) plan activities that use evidence-based, CS-specific teaching strategies saw the most dramatic increase from pre- to post-intervention.
- A major teaching practice change for many of the participants was increasing their use of student collaboration, specifically through pair programming or small groups, and to continue to do so in the future.
- The coaching program may help participants understand that they need to address implicit bias and how to do it.
- There was a slight decrease in participants responses to adopting practices to meet the needs of students with disabilities, using a variety of assessment strategies, and adjusting instruction based on student assessment data.
- The program may recruit educators that value multiple perspectives and likely supports the concept that highlighting multiple perspectives is important to effective teaching.
- Coaches offered participants feedback and guidance to improve their instructional delivery. Several participants implemented the feedback and some increased their use of inquiry based learning and scaffolding.

6.3 Policy Implications

Our initial findings show that coaching can be effective in increasing teacher confidence in and frequency of implementing inclusive teacher practices and these findings align to previous research [1, 3, 6]. National and local education agencies can consider prioritizing funding to establish coaching programs to support teachers after initial PD, especially those that focus on equity and reaching marginalized students. As states consider what it means to be a CS teacher, either through standards for teachers, licensure requirements, or in teacher education programs, consideration should be

given to building teacher knowledge of and capacity to use inclusive teaching practices. Given the socio-political climate within the U.S. and the intentionality to legislate how teachers approach learning for all, coaching can be a reprieve, offering a personalized learning pathway that addresses their unique classroom and students' needs. Teachers want and need to continue to grow, and customized PD through coaching can provide them with that opportunity.

6.4 Limitations

One of the limitations of this study is that the participants self-selected to participate, which likely means they were already motivated to change their instructional practice. We urge caution in extending the findings to teachers who are not interested in improving their practice. Relatedly, coaching like this is labor intensive and will need to scale at some level to have an impact on more teachers. This is being considered in future work.

Unfortunately, some of the coaching logs lacked details around direct support from coaches on addressing barriers to creating an equitable classroom environment for the focal group. Two coaches mentioned the focal group in the coaching log, but there was little to no evidence of coaches providing feedback on implementing equitable teaching practices related to the focal group. We viewed this more as insufficient prompts in the coaching logs than a lack of coaching by the coaches given discussions with coaches. However, this has been changed in the second year of piloting the program. Additionally, a different coach provided little to no feedback or guidance to the coachee related to the focal group even though the coachee was implementing equitable teaching practices. The coach's feedback generally was connected to CS or coachee's instructional practices. It should also be noted that all data included in this paper is self-reported and that further study using direct observation of classrooms is needed to understand if coachees implemented inclusive teaching practices with fidelity.

7 CONCLUSION AND FUTURE WORK

Coaching can be an effective way to provide ongoing PD beyond initial PD, offering teachers opportunities to grow in their practice in targeted areas specific to their needs and context. This study provides evidence of change in teacher's capacity to implement inclusive teaching practices (RQ1) and ability to sustain them in their practice (RQ2). As highlighted in the CS teacher landscape survey [19], coaching can address gaps in teacher confidence to implement practices such as culturally relevant pedagogy and making projects meaningful for students. However, more refinement of the coaching PD and accompanying tools (e.g., log) may improve coaching conversations that address the needs of focal student populations directly. Additional study is needed to understand teacher implementation in the classroom and its impact on students.

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