Early Childhood Teachers' Use of Asset-based Computational Thinking Pedagogy: Centering Students' Expertise and Life Experiences

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Purpose

Computational thinking (CT) is central to computer science, yet there is a gap in the literature on how CT emerges and develops in early childhood especially for children from historically marginalized communities. Yet, lack of access to computational materials and effective instruction can create inequities that have lasting effects on young children (Chaudry, et al., 2017). To alleviate the pervasiveness of such inequities and remedy the "pedagogical dominance of Whiteness" (Baines et al., 2018, p. 10), asset-based computer science CS pedagogies and culturally relevant approaches are needed (Madkins et al., 2019). Understanding how teachers provide asset-based, culturally responsive opportunities for CT in early childhood classrooms remains largely unknown. The purpose of this paper is to share a subset of findings from a qualitative, ethnographic study that explored the ways in which early childhood teachers (ECT) learned and implemented CT using asset-based pedagogies. The research question addressed is: In what ways do ECT use asset-based pedagogies while implementing CT in their classrooms?

Theoretical Framework

Asset based pedagogies are founded on the belief that students possess unique life experiences and abilities which can be leveraged to foster effective and meaningful learning experiences (Goodwin, 2005). Teachers who use asset-based pedagogies oppose deficit beliefs that focus on what learners lack, or on what they cannot do, and instead place value on students' strengths, insights, languages, and cultural practices. As a part of culturally responsive pedagogy (Ladson-Billings, 1995), asset-based pedagogies seek to critique injustices, oppression, and other social-political issues (Flint & Jaggers, 2021). We were interested in understanding how teachers used asset-based pedagogies in their implementation of CT that helped to "free students to be who they are and enable them to live effectively, appropriately, and justly" (Goodwin, 2005, p. 38) while advancing a vision of what is possible in computer science (Harper et al., 2023).

Literature Review

Asset-based, culturally relevant pedagogies (Flint & Jaggers, 2021; Goodwin, 2005; Ladson-Billings, 1995) incorporate students' insights, languages, and cultural practices into instruction to promote equity and agency in knowledge building. Emphasizing the value of each student's contribution, asset-based instruction fosters classroom community through reciprocal, inquiry-based learning. Principles such as valuing everyone's input, collaboration, and shared responsibility are embedded in instructional practices encouraging mutual support and collective

ownership of knowledge. Examples of such practices might include a teacher's use of inclusive language in the classroom, such as "we" "us" and "our", anchoring instruction in students' interests, and encouraging students to share their expertise with peers. Flint and Jaggers (2021) argue that asset-based approaches acknowledge multiple ways of knowing by centering students' expertise in the learning environment, thus engendering a sense of belonging, agency, and well-being among learners and teachers alike.

In recent years, intersections between computer science CS education and asset-based pedagogies have gained attention for their potential to enrich teaching methodologies and promote inclusivity (Harper et al., 2023; Jocius et al., 2023; Quinn et al., 2023). This surge in interest around asset-based approaches in CS education aligns with Grover's (2021) articulation of an urgent need to explore culturally relevant pedagogies. Grover (2021) argues that the field of CS education lacks a robust understanding of the affordances of such approaches and that deploying them in classrooms might point the way to broader participation across divergent populations and grade levels. Grover's (2021) argument underscores earlier calls to recognize and incorporate learners' cultures, languages, and experiences as assets for authentically engaging with computing (e.g., Madkins et al, 2019; Scott et al., 2015).

Broadly speaking, the attention to culturally relevant and responsive CS education aligns with asset-based approaches as defined by Flint and Jaggers (2021). For instance, Scott et al. (2015) explicitly describe culturally responsive teaching as a "stark contrast to deficit models of thinking…which fault students' personhood, communities, backgrounds, and families"—attributes that culturally relevant teaching values "as assets on which learning can occur" (p. 414). Similarly, Madkins et al. (2019) highlight the importance of aligning computer science curriculum and instruction with students' cultural backgrounds and experiences, because these asset-based strategies allow students to connect computer science to their daily lives.

Further supporting the shift towards asset-based pedagogies, McCormick and Hall's (2022) scoping review highlights a gap in early childhood CS education research, particularly the need to differentiate between "task-oriented experiences" and "opportunities for free or explorative play with CT tools" (p. 3803). From an asset-based perspective, open-ended approaches would empower learners to engage with computational concepts through self-expression, creativity, and connection with others, thus aligning with Flint and colleagues' (2021) call to value students' voices and choices in their learning processes.

Methodology

Context

We developed a yearlong teacher professional learning program centered on CT. The program drew on CT learning frameworks from early childhood CS education research such as Bers' Powerful Ideas (Bers, 2021) and Resnick's computational fluencies (Brennan & Resnick, 2012; Resnick, 2017), and on professional development research such as Ball's generative change theory (Assaf et al., 2016; Ball, 2009, 2020) and inquiry-based art education (Justice, 2020). Overall, we looked at early childhood teachers' learning and teaching practices as they

implemented CT in their classrooms. We positioned teachers as active learners and, in contrast to CS education research that mandates scripted CT activities or pre-written curricula, we did not tell teachers what to do. Instead, we introduced them to CT as an expressive meaning-making practice and invited them to reflect on their own learning while exploring opportunities for connecting CT with their students' learning.

We defined CT as a human way of thinking with computers, where thinking routines and practices shape and are shaped by working expressively with computational machines and programming symbol systems, e.g., by telling and making stories, games, and art. With Kafai and Proctor (2022) we think of computing broadly as a set of expressive practices with antecedents in and implications for widely diverse ways of knowing and participating in the world. As a component of K-12 education, we consider computing to be a broadly participatory literacy, where participation empowers and sustains communities of practice as well as individual and community identities.

The yearlong learning program kicked off with a two-week summer CT institute that framed CT as meaning making. The institute, leveraging art education frameworks (e.g., Hafeli, 2015; Pacini-Ketchabaw et al., 2017), implemented computational making activities with a material inquiry approach (Cabral & Justice, 2019; Justice et al., 2019). Material inquiry draws from a learning principle articulated by Hafeli (2015) as *purposeful play*, and from sociomaterialism's commitment to multimodal sensemaking as an entangled, materiality-infused literacy (Hawley, 2022)—for example, where a child's tap-tapping with a colored marker transforms a letter-making activity in a writer's workshop into a lightsaber battle (Wohlwende et al., 2017, p. 448).

At the summer institute teachers made stories and art for themselves and each other with computational tools and materials like Scratch, ScratchJr., and various robotics platforms. While doing so they explored the affordances of computer programming and robotics for meaning making and expression, and reflected on why introducing computing in their classrooms might be worthwhile. Readings, videos, and group discussions about CS education principles (Bers, 2021; Brennan & Resnick, 2012) and the effects of computing in the world were included. To leverage the serendipitous effects that materials can contribute to learning, and to help our novice participants through their first challenging encounters with these unfamiliar tools, we designed the curriculum as a series of purposeful play and inquiry activities, featuring:

- Art, science, and storytelling with screen-based platforms (Scratch, ScratchJr.) and screen-free robotics (KIBO, Ozobot, Edison).
- Low-floor challenges ("Make the sprite move!" "Make the robot dance!") with high-ceiling potential ("How did your family come to San Marcos, Texas?").
- Hands-on storymaking (Compton & Thompson, 2018) with computational tools and materials.
- Reading circles and reflective writing on the effect of computing on individual and community identities.
- Field trips to early childhood learning centers and cultural centers/museums.

- Individual and grade-level action plans for leveraging CT to support and extend what participants already teach.

At the institute we invited teachers to engage with a diverse set of computing challenges emphasizing process over product. For example, when learning *to do* something, like programming a robot to tell a story, we asked participants to focus on what they were learning and to document their journey with diagrams, sketches, and notes. We emphasized collaborative participation with reflective show-and-share sessions for both individual and small group learning activities. Throughout the institute we positioned ourselves as learners alongside the participants, as guides inviting exploration rather than as experts with ready answers or step-by-step instructions for each and every challenge.

Researcher Positionality

As teacher educators we work in complementary educational fields, literacy (Assaf) and art (Justice) and share a commitment to culturally relevant education. This study emerged from interests in the contrasts (and contradictions) between learning to teach in expressive domains such as art and writing, and in domains normally thought of as less expressive, such as computer science and STEM. Our individual research (Assaf et al., 2020; Justice, 2017) looks at education from equity and inquiry perspectives, where teachers' identity work (Brown, 2022) empowers and sustains their learning as well as that of their students and their students' families.

Participants

Participants included in the larger study came from two cohorts of preK to 2nd grade classroom teachers, specialists, and one elementary school principal (n=28). Teachers had an average of 12.5 years of experience. Teachers worked in the same school district with many at the same schools. The majority of students in the district are non-white (80%), economically disadvantaged (70%), and 10% speak English as an additional language. This article focuses on 10 participants from Cohort two (N=10). Table 1 provides a summary of participant demographics. Pseudonyms were used for all participants.

(*Insert Table 1 here.*)

Data Collection and Analysis

Qualitative methodology guided the data collection and analysis of this study. Interviews, classroom observations, and teaching videos were collected from two cohorts of 28 participants (pre-K-to-4th grade classroom teachers, specialists, and an elementary school principal in one public school district in the Southwest) during a yearlong professional learning project that included a two-week summer institute, follow up coaching, observations, and group meet ups. We focused on 10 participants from Cohort 2 for this presentation. Interview transcripts and classroom observations were coded on the key tenets of asset-based pedagogies (Goodwin, 2005). Teaching videos were used to triangulate the data.

Findings

Analysis revealed two overarching themes and multiple sub themes that illustrate the ways in which teachers implemented asset-based pedagogies while teaching CT in their classrooms. Themes and subthemes are described below. Table 2 contains examples from participant interviews to illustrate each them and subtheme.

Theme One: Social Learning in a Classroom Community

All the teachers described how developing a classroom community as an asset-based practice supported students' understanding of CT. Within this larger theme, we identified four sub-themes that highlight the different ways participants nurtured and shaped their classroom communities to enhance students' CT abilities. Below we describe each sub theme followed by a chart with evidence from that analysis.

Intentionally Developing Community

This sub theme represents instances where teachers described the importance of a community in their classroom and how they intentionally nudged students to collaborate and support each other. Participants believed that learning in a community provided excellent opportunities (more so than most of their direct-teach lesson requirements) to nurture CT learning. Teachers relished seeing their students engage in collective problem solving and sharing resources within the classroom community.

Students Collaborating and Helping Each Other

Within this sub theme there were two different kinds of helping: a) helping that students did without being coached or asked to do so, and b) helping that was catalyzed by teachers changing the way they assisted students by encouraging collective sharing. It seems that on some level, the students just started helping without being coached by the teacher, and most teachers recognized that as a strength of working with CT materials. Teachers also believed that helping nurture and sustain a stronger community of learners (by working with ScratchJr., KIBO, or with other CT materials) enhanced students' CT learning. By telling students to ask their peers for help (and not the teacher), teachers believed they were creating a learning environment where everyone was positioned as an equal and valued learner. This is important because it moved the need for expertise out of the teachers' role and put it into the students' domain.

Students Sharing with Each Other

As an aspect of nurturing a community of learners, all the teachers invited students to share with one another during and after CT activities. For many teachers, the sharing was purposeful—it nudged students to publish their creations and talk about their learning processes, as well as to ask for help and problem-solve together. When students shared, they also showed the teacher how much they knew, which reinforced asset-perspectives of the students. Sharing during CT time was often talked about in similar ways as sharing after writers' workshop, where students were authors of their creations and were provided the time and space to share and get

feedback. Teachers also noted how much students appreciated sharing—"They love it"—and said they continued to create times and spaces for sharing because students demanded it.

Inclusive talk

Teachers' and students' language shifted to be more collectively inclusive by using pronouns like "we" or "our". Many teachers became aware of how they changed the way they talked about helping their students—for instance, instead of jumping in and telling students, "This is how you do it", teachers began by asking "what do we notice" or "what do we want to change?" As such, teachers' statements became questions and invitations for students to solve problems together. We also see evidence of students' language becoming more inclusive when they helped other students or when they talked about projects with peers.

Theme Two: Becoming Aware of Students' Interests and Abilities

This theme illustrates how the teachers shifted their views of students' abilities, specifically related to CT. Teachers consistently expressed a sense of surprise and excitement about how quickly and easily their young students engaged and collaborated in CT activities such as ScratchJr. and programming KIBO robots.

Centering Expertise: Naming and Positioning Student Experts

In this sub theme, we see teachers centering students' strengths and abilities by naming and positioning them as experts in their classroom. Several teachers wrote students' names on the board, listing them as experts in specific CT abilities (Expert in Algorithms or Audio Expert). Other teachers created and passed-out expert name tags to students both to recognize their abilities and to position them as experts in the classroom. By naming students as experts, teachers built community capital in CT across the learning community.

Leveraging Experts: Students Teaching Other Students

As teachers named and positioned their students as experts in their classrooms, they reinforced the need for students to help and teach each other. Leveraging student experts shifted the roles and responsibilities of learning and teaching CT in the classroom.

Releasing Expertise: Teachers Not the Experts

In this sub theme, the teachers shared that they did not need to be the CT authority because they recognized how quickly their young students were learning CT, and how capable they were of solving problems and supporting one another. Teachers said that releasing expertise was a relief.

(Insert Table 2 here.)

Discussion

This study addresses a gap in early childhood CT education by documenting the emergence of asset-based pedagogies in participants' classrooms. That is, we did not mandate

asset-based approaches during the learning program or tell teachers what CT activities to do with their students nor how to do them. Nevertheless, findings reveal that teachers adopted asset-based pedagogies when teaching with CT tools and materials. Several effects of this adoption can be aggregated from teachers' interview excerpts above, including:

Empowering Teachers as well as Students

Teachers recognized that an asset-based approach to CT instruction empowered not just their students but also themselves. Teachers talked about moving away from being the sole experts to becoming facilitators of a learning community and noticed that shifting their position in the classroom enhanced student agency. This move fostered a more dynamic and collaborative learning environment and, broadly speaking, made the teachers happier because they loved seeing their students collaborate and learn together.

Impact on Classroom Community, Learning and Implementation

Findings illustrate asset-based CT pedagogy enhanced social learning and community building in the classroom. Teachers described students becoming more collaborative as they helped and learned from each other, which amplified their engagement with CT activities and nurtured the teachers' commitment to implementing CT in their classrooms.

Surprises and Innovations in CT Engagement

Teachers expressed surprise at the ease and enthusiasm with which young children engaged in CT activities. Teachers' successes with asset-based CT approaches convinced them that young learners are more capable of complex thinking and problem-solving than they had assumed.

Teachers' Insights

As researchers who are simultaneously teacher educators, we were surprised at the insights participants expressed during interviews, classroom observations, and cohort meetups. Teachers repeatedly said they noticed—

- The ease with which young children, even in early childhood, can grasp and engage with computational thinking concepts when taught in a context that values their insights, backgrounds, and experiences.
- The significant role that community and collaboration play in enhancing CT learning among young students, moving beyond individualistic approaches to embrace more collective, supportive learning dynamics.
- The potential for asset-based and culturally responsive pedagogies to transform not just the way computational thinking is taught but also how subjects across the curriculum are approached, with implications for broader educational reform.

Prompting and Nurturing an Asset-based Approach

As stated above, we did not explicitly mandate an asset-based approach during the summer institute. Nevertheless, teachers said they noticed asset-based techniques and strategies, even if not by that name. That is, teachers recalled that we released expertise by refusing to give explicit answers during computational making challenges:

> Participant: I gotta figure it out and try to work through it.
> Interviewer: And did you learn this from the institute?
> Participant: I feel like yeah, 'cause y'all did that a lot. I know he [a male researcher] was, "Well, what do you think?" "Well, I don't know. I don't know." He did a lot of that. (Yvette, 4th/5th grade teacher)

Teachers also talked about how their learning was mediated by the learning community helping each other, and how that experience prompted them to create similar experiences for their students:

> Participant: I told that kid, "Can you show them what you did?" Because that's something we did at the institute. When I didn't know something, I would look around [to find] which teacher looked like they're successfully moving on, and then I would ask them, "How did you do that?" (Daniella, 2nd grade teacher)

Whether attributable specifically to the summer institute or to a combination of other factors (e.g., other components of the program such as meetups or coaching sessions, or to teachers' prior exposure to inquiry-based learning), findings suggest teachers' adoption of asset-based approaches influenced classroom dynamics and transformed their roles and identities—from expert to non-experts, from direct-teaching to designing inquiry and play experiences. As teachers enacted asset-based and culturally relevant teaching principles, they began to talk about how decentralizing their authority in the classroom opened a way toward collaborative learning in a classroom community. This shift, they said, had been influenced by their own learning experiences during the program and by their observations of the impact CT was having on student engagement and agency.

What Comes Next

In this study, findings show that participants' adoption of asset-based and culturally responsive pedagogies positively affected CT education in their classrooms. Teachers' own learning experiences and their recognition of their students' successful CT learning suggest there is more to learn about how to model and teach these approaches in professional learning programs for teachers. Future research should explore ways in which asset-based pedagogies can be deployed more widely and the impact they have on students' learning.

- Expanding the implementation of asset-based CT pedagogy across different contexts and age groups to explore its broader applicability and impact.
- Investigating the long-term effects of early exposure to asset-based CT pedagogy on students' computational thinking skills, attitudes towards computing, and overall academic trajectories.
- Exploring professional development models that prepare educators to adopt and implement asset-based and culturally responsive teaching practices in CT and beyond.

Conclusion

By using asset-based CT pedagogy, teachers supported students' identity development and increased their engagement and interest in CS (Madkins et al., 2019). They gained a deeper understanding and critique of inequities in computing and provided instruction that challenged deficit beliefs that too often oppress and limit students who have been historically marginalized (Scott et al., 2015). Asset-based pedagogy served as a catalyst for change in how teachers' viewed students' abilities and how they integrated CT.

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Table 1: Participant Demographics (N=28)

Cohort 1 June 2021 – May 2022 (N=13)		**Cohort 2 June 2022 – May 2023 (N=15)**	
10 Females (8 White, 2 Latinx) 3 Males (2 White, 1 Asian American)		**13 Females (4 White, 9 Latinx) 2 Males (1 White, 1 Asian American)**	
Teaching Level	**n**	**Teaching Level**	**n**
Pre-K	1	Pre-K	2
Kinder	4	Kinder	4
1st Grade	0	1st Grade	1
2nd Grade	5	2nd Grade	2
Admin (Principal)	1	4th/5th Grade	1
Specialist	2	Specialist	5
Teaching Experience	**n**	**Teaching Experience**	**n**
1-3 Years	3	1-3 Years	3
4-8 Years	2	4-8 Years	2
9-18 Years	8	9-18 Years	10
CT Teaching	**n**	**CT Teaching**	**n**
Survey question: "How often do you use computational thinking or computer programming in your classroom teaching?" Lickert-style response options: Never (1) - Always (5).			
Response 1	3	Response 1	5
Response 2	8	Response 2	4
Response 3	2	Response 3	2
Response 4 to 5	0	Response 4 to 5	0

Table 2: Examples from the Data

Theme One: Social Learning in a Classroom Community	
Sub-Theme	Quotes
Intentionally Developing Community	"I work hard to make my classroom a community." *—Janet, 1st grade teacher* "We help each other. The story I tell them is that if there's a race, …and the winner [is] going to get some candy…. [The] kids decided they all wanted to win, so they held hands and all rushed together so they could all share the gift—they didn't want to leave anyone behind. If you know something, share it with your buddy. Everyone has to get there together." *—Daniella, 2nd grade teacher*
Students Collaborating with & Helping Each Other	"What I learned about it—in the sense of debugging—...[was] how well they used their language to collaborate with each other and try and debug [together]." *—Janice, Kindergarten teacher* "We've been working in our campus on structured conversations. And so, knowing that they will have a partner and that they will be able to share using the sentence stem is really helping them talk to each other and supporting each other on their thinking." *—Celeste, Kindergarten teacher* "They really do help each other in the classroom…. If somebody needs help, they're really sweet. … And from day one, it's like when your friend needs help, we're gonna help them out." *—Yvette, 4th/5th grade teacher*
Students Sharing with Each Other	"We try to wrap up our coding with sharing.… We usually try to do at least one prediction [where students guess the code after watching the animation]. I usually try to do a pretty simple one, that I can predict…without looking at it myself. Because I do think it's important that they're able to kind of put those together. And I like when the kid who wrote the code knows what they wrote, and they're like, 'No, it's not that.'" *—Honoria, Kindergarten teacher* "Well, they all want to be seen, they all want to be heard. They want to show off what they feel successful at, or they need just that extra boost of confidence [from sharing]." *—Janet, 1st grade teacher*

Inclusive talk	"They'll show their friends at their table. So, [I'm] just trying to give them a little nudge in that direction of like, 'Hey, let's see what we can do.'" *—Sebastian, 2nd grade teacher* "In science when we did our circuits, 'It's not working.' I'm like, 'Well, what happened? What can we do?'" *—Yvette, 4th/5th grade teacher* "When they were given their own box with their own KIBO, I just saw fireworks. It was just, 'Let's do this', and 'Let's do that.'" *—Alina, Pre-Kindergarten teacher*
Theme Two: Becoming Aware of Students' Interests and Abilities	
Sub-theme	Quotes
Centering Expertise: Naming and Positioning Student Experts	"They have these little name tags that say that they're the coding teacher for the day." —Celeste, Kindergarten teacher "I have another student who's a pro at getting himself to record his voice, so he is the expert in that specific task." *—Honoria, Kindergarten teacher* "Ask me a question, even in ScratchJr, and I'm like, 'Oh. Hold on, friends. I need your attention. Somebody's got a question. He needs to know something about the backdrop, or he has a question on a Sprite. Anybody here an expert on Sprites?'" *—Bridget, Kindergarten teacher* "'You need to be gentle with KIBO.' So, just hearing things I've said and having them repeat shows me they've heard, and they've processed, and they've understood. And now they're teaching it or re-teaching it to another student." *—Alina, Pre-Kindergarten teacher*
Leveraging Experts: Students Teaching Other Students	"'Let's have somebody show us how to move the character.' And so, then somebody came [up] and showed us how to move the character." *— Celeste, Kindergarten teacher* "I'm acting like I have no idea what's happening. I'm like, 'I don't really know what you're doing. It looks really cool though. I wonder if there's another friend here that knows anything about this.'" *— Bridget, Kindergarten teacher*

	"I would say my approach has changed a little bit …because in the past I would have gone with the traditional 'I do, we do, you do.' And with this, especially with the KIBO, I felt myself [changing] because I give them a few minutes and then have them come back together. 'Okay? Well, what did we notice? What didn't work out so well? How can we fix it?' Like, guiding them in those discussions without the 'I do, we do.' It was straight to the 'you do'—you figure it out." *—Janet, 1st grade teacher*
Releasing Expertise: Teachers Not the Experts	"And it's okay that I'm not the teacher. I think that was the main thing I got out of the [program]. That I'm not the answer of all things. And so, really taking a step and being just somebody on the side and having them learn through each other." *—Celeste, Kindergarten teacher* "A lot of it was just letting them take the lead and explore it, and then teach each other." *— Janet, 1st grade teacher* "Oh, my students love coding. I am not an expert. I am no expert at all. But they love coding. So, I'm kind of still learning with [them]." *—Yvette, 4th/5th grade teacher*