Accessible Computational Thinking (ACT):

Bringing Culturally Responsive Computing into Elementary Science

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#2101526 & #2101039: Collaborative Research: Accessible Computational Thinking in Elementary Science Classes within and across Culturally and Linguistically Diverse Contexts

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INTRODUCTION

BACKGROUND

- Broadening participation in computing-related fields requires early and equal exposure to computer science (CS) for *all* students
- Elementary science classes serve as an ideal venue for the integration of computational thinking (CT), laying foundations for developing CS interests

PRIOR WORK

- **Previous grant** : The Science Teaching Computational Thinking Inquiry Group (STIG^{CT})(# 1639891)
- **Lessons learned** : without emphases on equitable approaches, some teachers perceive CT as only for students with existing interests in computing rather than for *all*[1]

CURRENT GOALS

- ACT supports elementary educators to integrate **CT** into **science** classes using Culturally Responsive Teaching (**CRT**) practices through 2-year professional development (PD)

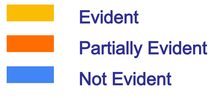
RESEARCH QUESTION

Big RQ: How do elementary teachers develop the skills and dispositions to provide access to CT-integrated science lessons incorporating Culturally Responsive Teaching (CRT) practices for culturally and linguistically diverse learners?

FINDINGS

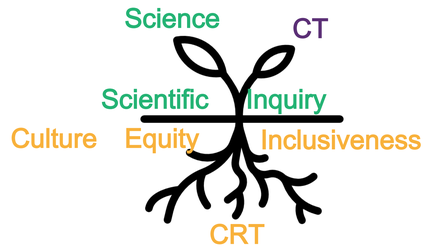
Teachers integrate CT and CRT in science through various pathways, orders, and patterns – there's no unified way to learn.

PATHWAYS OF INTEGRATION



In the lesson plan poster teacher created at the end of Summer 1, some CRT practices are more evident (e.g., *Modeling High Expectations*) while some are rare (e.g., *Speak up about and Respond to Prejudice, Bias, and Stereotypes*) despite of their authentic attempt. [2]

UNDERSTANDINGS OF CT AND CRT



During PD, teachers' understandings of CT evolved synchronously and convergently as an independent construct like a "sprout," while their growth of CRT is asynchronous and divergent, deeply "rooting" down in their identities, experiences, and beliefs. [3,4]

TEACHER SELF-EFFICACY (SE)

- Teachers' SE in CT integration decreased from PD1 to PD2 ($t = 2.569$, $df = 16$, $p = 0.021$).
- Teachers with high SE had false beliefs about their abilities to integrate CT, while teachers with low SE successfully integrated CT, but their physiological and affective states prevented them from accessing mastery experiences which may have benefited them. [5]

IDENTITY AND CONTEXT

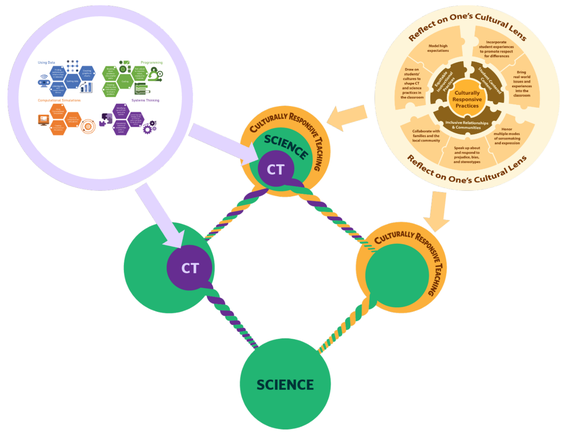
Teachers' definitions and enactments of CT- and CRT-infused science morphed across various learning spaces, impacted by whether they feel included or excluded by their small group in PD, dynamics with the researchers, how they connect their personal identity with students' need, and their school's demands [6]

IMAGINING FUTURE PD FOR CT-CRT-SCIENCE INTEGRATION

- Address **diverse learning trajectories** , especially providing thorough and context-aware support for the more challenging practices (e.g. *Speak up about Prejudice*) [2,3,4]
- Provide teachers with clear and timely **feedback** on their performance that supports their mastery experience in their journey towards high self-efficacy in integration [5]
- Be **teacher -centered** through mitigating the researcher-teacher power dynamics, reflecting on researchers' positionality, and honoring teachers' expertise, experience, and identities [6]

APPROACHES

FRAMEWORKS AND MODELS[7]



PD TIMELINE AND DESIGN

	FORMAT	MEASURE
SUMMER 1	5-day workshop on CT and CRT in science learning	Teacher artifacts, focus groups, and surveys
YEAR 1	Class teaching with coaching	Classroom observations and interviews
SUMMER 2	3-day workshop based on outcomes and reflections	Class teaching with fading support
YEAR 2	Teacher artifacts, focus groups, and surveys	Classroom observations and interviews

SITES AND PARTICIPANTS

SITE A	SITE B	SITE C
Southwest 24 teachers	Mid-Atlantic 10 teachers	Mid-Atlantic 7 teachers

[1]Killen, H., Coenraad, M., Byrne, V., Cabrera, L., Mills, K., Ketelhut, D. J ., & Plane, J . D. (2023). Teacher education to integrate computational thinking into elementary science: A design-based research study. *ACM Transactions on Computing Education* , 23(4), 1-36.
[2]Bernier, J ., Kramarczuk, K., Terrell Shockley, E., Figueroa, F., Yan, L., Xin, Y., Mak, J ., Su, M., Ketelhut, D., & Nelson, B. (2024, March). CT+CRT+Science: Pathways to Integration in Elementary Teachers' Lesson Plans. *NARST 2024 Annual Conference* .
[3]Xin, Y., Kramarczuk, K., Mak, J ., Terrell Shockley, E., Ketelhut, D. J . (2023, March). Computational Thinking-Integrated Elementary Science with Culturally Responsive Teaching: A Vignette Study. *The 54th ACM Technical Symposium on Computer Science Education (SIGCSE 2023)* , Toronto, ON, Canada.
[4]Xin, Y., Su, M., Mak, J ., Coen, A., Figueroa, F., Kramarczuk, K., Ketelhut, D., Lin, Y. (2024, April 11-14). Two Trajectories: Elementary Teachers' Evolving Understandings of Culturally Responsive and Computational Thinking Infused Science Teaching. *AERA 2024 Annual Conference* . Philadelphia, PA, United States.
[5]Figueroa, F., Coen, A., Ketelhut, D., Nelson, B., Kramarczuk, K., Mak, J ., Yan, L., Xin, Y., & Terrell Shockley, E. (2025). Teacher Self-Efficacy Implementing CT-Infused Elementary Science Lessons. [Roundtable]. *AERA 2025 Annual Conference* .
[6]Kramarczuk, K., Bernier, J ., Mak, J ., Figueroa, F., Terrell Shockley, E., Xin, Y., Yan, L., Nelson, B., & Ketelhut, D. J . (Under Revision). A matryoshka doll of elementary science teacher positionalities: Implications for computational thinking and culturally responsive professional development. *Journal of Science Education and Technology* .
[7]Mak, J ., Xin, Y., Yan, L., Kramarczuk, K., Figueroa, F., Nelson, B., ... & Ketelhut, D. J . (2025). Accessible Computational Thinking in Elementary Science: An Aligning Framework for Teacher Learning and Implementation. *Journal of Technology and Teacher Education* , 33(1), 67-107.

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