Fostering intersectional identities through rhizomatic learning

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***Abstract*—Many scholars have produced powerful equity-centered curricular and pedagogical approaches relevant to CS educators. However, well-intentioned educators and curriculum providers who intend to use culturally relevant approaches may mistakenly apply these frameworks and unintentionally enact what we refer to as "culturally specific" approaches to education. Such approaches fail to account for students' multifaceted experiences of culture and identity in the design of their learning experiences, ignoring their specific needs, goals, and desires for their learning. Rather than delivering content for groups of culturally specific identities, this position paper describes a "cartographical" curricular and pedagogical approach informed by a rhizomatic philosophy of learning that fosters dialogue among students as individuals with unique identities, interests, and needs that teachers and students explore together through computer science education. We position rhizomatic pedagogy as an additional lens to apply alongside other frameworks for fostering equity—one that establishes a set of strategies for engaging students in dialogue around their learning experiences, empowering learners to participate in the co-construction of their educational spaces, and building curricula that express hyper-local, deeply situated, student-centered teaching and learning practices.**

Keywords—Individualized learning, Rhizomatic learning, Curriculum mapping

I. Introduction

Since Ladson-Billings' [1] foundational work on culturally relevant pedagogy, many scholars have introduced similar equity-centered curricular and pedagogical approaches, including culturally responsive pedagogy [2], culturally-sustaining pedagogy [3], and more recently, culturally responsive-sustaining computer science pedagogy [4]. Equity-centered approaches like these intend to ensure "that students' interests, identities, and cultures are embraced and affirmed" [4, p. 11]. However, we argue that well-intentioned educators and curriculum providers who intend to use culturally relevant approaches often mistakenly use what we refer to as *culturally specific* approaches to education. Culturally specific curricula and pedagogies treat a collection of students as groups within a narrowly defined lens of "culture" (e.g., a single demographic such as gender), rather than as individuals with unique and intersecting identities, interests, and needs. These approaches fail to engage teachers and students in a Freirian dialogue, one that positions students as co-investigators of their own education through a learning process that should not "become a simple exchange of ideas to be 'consumed' by the discussants" [5, p. 82].

Consider a hypothetical educator who uses a culturally specific curriculum and pedagogy to differentiate CS instruction based on whether a student identifies as female, male, or nonbinary. Although CS education scholarship might propose a multitude of evidence-based approaches designed for each of these three gender categories, these design and implementation strategies are insufficient for addressing the multiplicitous nature of humans' interests, desires, and learning needs across intersections of gender, culture, race, and marginalization. For example, how might a curriculum designed for female, male, or nonbinary students also differentiate for someone who is transitioning between genders? What about for nonbinary students who are Black compared with nonbinary students who are White, Pacific Islander, or even mixed race? What about for a White, nonbinary student in a low-income rural community who is trilingual and has limited English proficiency compared to a Pacific Island, female student in a high-income urban community who is monolingual and has advanced English language proficiency? If the hypothetical educator expands beyond differentiating for gender to include more identities, how many cultural layers and intersecting identity permutations will they differentiate for? If an underrepresented identity or marginalized culture is excluded from this intersecting web of differentiation, is the educator unknowingly reinforcing oppressive power structures or engaging in various forms of colonization? Curricula designed at scale often fail to express learning experiences that embrace students' intersecting cultures, identities, and social contexts, and offer very little support to teachers seeking to accommodate their specific learners' needs.

This position paper describes a curricular and pedagogical approach that engages in continual dialogue with students as individuals with unique identities, interests, and needs that teachers and students explore together through computer science education. We begin with a vignette of a classroom where educators and learners co-design learning experiences through continual dialogue. Next, we unpack the practices and approaches illustrated by the vignette using a metaphor that positions teachers and learners as *cartographers*. We then discuss pedagogy that is conducive to teachers and students collaboratively mapping individualized journeys through CS education. Finally, we discuss theoretical frameworks which inform this approach. We argue that engaging learners in collaborative, dialogical learning experiences offers a strategy for avoiding culturally specific pedagogies and embracing more responsive equity-centered computer science teaching.

II. Mapping

The following subsections articulate one possible vision of "cartographic" pedagogy, where educators engage students in the co-construction of a collective learning experience. We embed practical suggestions for practitioners throughout our illustration of a cartographical orientation to CS pedagogy.

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II.A. Planning and Widening Paths

Imagine walking into a classroom and having your attention immediately drawn toward a "map" on a bulletin board that nearly covers the largest wall in the classroom. On the map is a colorful display of index cards that each represent a different CS concept or practice that students have engaged with so far that year, along with some unexplored extras that the teacher has provided to tease potential new directions to explore. Most of the students have chosen to create simple videogames during the semester, so a lot of the index cards deal with domain-specific game development topics—drawing and animating a sprite, using a button to control the value of a variable, creating objects to represent game entities, etc. The teacher has organized the color coded index cards such that the simpler topics are to the left, with the more complex topics further to the right side of the board. Interspersed throughout the map are several student-created project cards that show the unique projects that members of the class have worked on so far. These cards display where the projects lie in relation to the concepts and practices displayed on the map, and include a long piece of yarn connected to various concepts and practices that were used in a project.

As you continue to scan the classroom, you notice students in various group sizes are spread throughout the class discussing a variety of ideas and topics. Each student is in charge of their own goals for what they will explore and create in their next project, even when choosing to collaborate within a group. After much discussion, the teacher asks students to write their project ideas on new index cards and pin them to the map in a location that they think is best situated within the variegated CS concepts, practices, and projects. After much discussion with their peers, one student named Morgan has decided to change their focus to a project topic that has not been explored by anyone in the class yet, so they place their card in a relatively empty area near the right side of the board. Once everyone has added their cards to the map, the students begin tracing an anticipated path they will traverse as they work on completing their projects over the next few weeks. Dakota was really inspired by Riley's project from last month, so they have decided to create a similar game with a couple of new features. When pinning their project near Riley's previous project card, they use Riley's prior yarn trail as a starting point and potential guide for creating a similar project, retracing known paths. Most students, however, quickly realize that the already worn paths often miss concepts and practices needed to complete their new project variations. With help from their teacher, they do their best to predict what concepts and practices they will need to develop to bridge these gaps, and add new cards to the map; however, everyone in the class understands and expects their actual paths to deviate from their initial plan once they get going.

Once students have mapped their path, the work begins. Some students start reviewing old concepts, practices, and projects from earlier in the year, while others jump into exploring the new concepts and practices they will need for their project. Throughout the year, students and the teacher collaboratively expand upon the map by providing videos, examples, tutorials, and other resources to use when new complications and unexpected challenges arise. As students trace their paths, they add new yarn trails to the map for other students to build upon in the future.

The vignette above illuminates an approach for teaching learners to code by engaging them in *mapping*; a pedagogical technique that poses map-making as a heuristic for how educators and learners might collaboratively engage in curriculum design, learning, and reflection in formalized learning contexts. Rather than building experiences for learners, this fictionalized story illustrates how educators might build learning experiences with them by engaging in continuous dialogue with each learners' goals, identities, interests, and needs throughout the project work and in the instructional design process. This *cartographical* approach contrasts with culturally specific approaches to education which place learners within groups and ask them to collectively traverse worn paths designed for a particular "culture" or identity. In other words, instead of assigning learners to paths designed for a particular group, a mapping approach encourages learners to choose, widen, or forge their own path through a collaborative exploration with, and through dialogue between, both peers and educators.

II.B. Keeping On the Grass

Imagine computer science as a vast wilderness, and learners as travelers in it. As learners explore the territory of computer science, they come to know things within computer science the same way someone might come to know a distinctive tree or an abandoned barn nestled deep in the woods. These *locations* represent the things people come to know about computer science or a computer science subdomain. But learners do not often wander aimlessly, stumbling upon new ideas and topics—instead, they often pursue a goal, something they want to be able to do in the domain. This goal is like a *landmark* peeking up over the tops of the trees, visible to the learner from a great distance: a granite cliff face or an old fire tower. The learner will stumble upon new locations as they travel from where they are (what they know) to where they want to be (what they want to know). When the learner keeps a record of their path, they create a *map* of their learning experience that other learners might retrace or analyze later.

In practice, mapping involves balancing the work of defining a domain, setting learning objectives, and scaffolding students' learning between educators and learners. Mapping contrasts sharply with a "backward design" curricular design strategy [6], where the teacher defines learning objectives (landmarks) for students, and supervises students as they all trace a predefined sequence together. Backward design situates the educator as the bearer of knowledge who guides learners along the "correct" learning path. These paths, however, resemble sidewalks meant to keep students off the grass by guiding them along a route with limited deviation from the original design. In addition, these paths are often not chosen by a learner to match their own goals, identities, interests, and needs, but instead are assigned by external curriculum developers or by an educator. Backward design fails to create space for dialogue among learners and educators, instead placing instructional design authority in the

teacher's hands alone. In contrast, mapping encourages each learner to widen previously worn paths and to forge new paths altogether by metaphorically keeping off the "sidewalk" and on the "grass." Although mapping might interest educators who feel constrained by boundaries imposed by culturally specific curricula, the uncharted nature of mapping can also overwhelm educators and students through the unscripted choice. To support educators interested in getting started with mapping, we provide a process modeled after the lessons we learned from our own experiences engaging in learner-centered dialogue while working with students kindergarten through doctoral; however, we want to emphasize that this approach is but one of many potential paths.

II.C. Mapping Territories

The process for mapping territories might begin by establishing a domain that learners will begin exploring as part of their learning experience. In the vignette above, students started the semester creating videogames, but computer science education is host to many possibilities: visual art, robotics, generative music creation and performance, and many others. These domains (or *territories*) serve to situate learners within a field of known and unknown ideas and skills. Similar to the artificial borders drawn on a map, these domains often impose disciplinary conventions and contrived boundaries that students will soon begin to dismantle.

After choosing a domain, the next step is to map landmarks situated within the territory. These are the "projects" that students identified in the vignette. These landmarks are concepts and practices worth knowing, skills worth developing, and interesting places in the domain that a learner might use to set their compass toward and seek to come to know or create. In addition to using the landmarks to guide their individualized learning, learners might also use landmarks to identify their prior knowledge, taking stock of any locations they have already visited.

After identifying landmarks, learners and educators begin blazing trails between the locations they already know and the landmarks they wish to pursue. They identify missing skills and knowledge they need to reach a landmark, and co-create learning experiences with peers and educators to help themselves acquire these skills by finding resources, analyzing examples, seeking out experts, and following trails left by other learners. Peers and educators are valuable resources here—they are able to help learners identify missing skills and knowledge through dialogue or assessment, and can design or recommend learning experiences to help the student develop these skills as they pursue their goals. At the close of a project, learners and teachers reflect on their learning experiences by mapping their learning, writing down how they went about pursuing their landmark such that a future traveler might retrace their path or build on it as they pursue related goals. Finally, learners compare their journey in relation to prior projects and understandings, then set new goals for their next project.

In the vignette above, the class created their map collaboratively on a bulletin board. Maps can take many physical or digital forms, but what they have in common is they render a particular learning experience as a path from one position in a territory to another—a *trail* across the domain. Learners' maps are particularly useful when they show many trails together; learners will find that some locations reappear across different projects, while others are more remote.

When educators map curriculum through continuous dialogue with learners rather than for them, they embrace a deeply responsive pedagogy that positions learners as designers of their educational experiences. Learner's self-determined maps are inherently self-differentiated; they are designed around that individual's goals, needs, background, desires, strengths and weaknesses. Mapping systematically centers learners' voices, and positions the educator as a supportive expert who provides context and mentorship. The curricula that emerge out of cartographical pedagogies—the trails that people generate as they learn—are both reflections of past learning and tools to scaffold future learning. They represent one person's path toward one person's goals, but they also provide material that other paths might grow upon.

III. Re-Tracing Trails

Irvine describes a tendency for researchers to treat teachers and students "as mere objects of their gaze" [7, p. 33] through a one-way description of participants without "inviting anyone from the community to speak up and back to the researcher's interpretations" [8, p. 161]. Similarly, and despite their positive intentions, educators risk implementing equity-centered approaches in ways that essentialize or reduce students' educational needs or preferences to a single caricature of a culture or identity. In contrast, when teachers invite students to participate in the design of their learning experiences through dialogue à la Freire [5], they create opportunities for students to express and explore their unique set of identities and experiences in all of their many nuances.

The cartographical approaches to teaching and learning described in this paper are informed by "rhizomatic learning" [9, 10, 11, 12, 13], a teaching and learning theory [14] that embraces situated teaching and learning [15] and rejects the practice of establishing staid fields and static disciplinary boundaries. Teachers and students engaged in rhizomatic learning trace new and established paths through computer science in continual dialogue with one another, developing skills and knowledge situated by their individual goals, needs, and desires. Rhizomatic learning offers a conception of CS that is "constructed and negotiated in real time by the contributions of those engaged in the learning process" [10], a field constructed socially through dialogue rather than one imposed upon learners by educational institutions.

We argue that mapping as described above expresses a *rhizomatic pedagogy*, a set of practices that facilitate, cultivate, or produce rhizomatic learning and teaching. Rhizomatic pedagogy involves dismantling hierarchies among educators and learners, creating space for collaboration among everyone in the learning space, and following the interests, desires, and goals of learners toward creating personalized learning sequences that value students' agency in their journeys as learners. Rhizomatic pedagogy involves centering learners' agency throughout the educational process, while at the same time scaffolding their engagement to ensure they are successful in making use of

their agency. By engaging in rhizomatic pedagogies, teachers and learners engage in a Freirean dialogue [5], where the teacher constructs knowledge in collaboration with learners rather than paternalistically tracing paths for them. Rhizomatic pedagogy offers teachers and learners a powerful framework for implementing responsive, localized, participatory learning experiences rather than using curricula as a tool for casting learning experiences in a mold and replicating those experiences across social, cultural, and intersectional contexts.

Rhizomatic learning practices are resonant with many well-established equity-centered pedagogical approaches. We do not intend to position mapping or rhizomatic pedagogy as a replacement for the important work of other scholars and educators addressing systemic oppression and inequity in education. Rather, we position mapping as an additional lens to apply alongside other frameworks for fostering equity—one that establishes a set of strategies for engaging learners in dialogue around their experiences, empowering learners to participate in the co-construction of their educational spaces, and building curricula that express hyper-local, deeply situated, learner-centered teaching and learning practices.

We argue that co-constructing learning experiences built around learners' goals, interests, and desires offers educators powerful strategies for providing individually responsive and relevant CS education experiences; particularly for learners whose intersecting identities, goals, interests, desires, or experiences are marginalized. Cartographical pedagogies offer many questions and challenges for computer science educators to address in future work. Many computer science curriculum providers, teacher education programs, and computer science education researchers offer generalized teaching and learning resources designed for many classrooms across many contexts. While these resources may offer powerful capacity-building tools for novice computer science educators, they fail to help teachers build skills and dispositions that create space for learners to participate in the design of their educational experiences. As we reflect on the role of rhizomatic learning in computer science education, we ask: What might curricula that encourage cartographical teaching and learning practices include, and what do they exclude? What skills should professional development providers model and teach to help teachers feel empowered to center their students' goals, needs, and desires in their classrooms? What new curricular and pedagogical approaches might students and teachers develop through continuous dialogue with each other as they embrace their hyper-situated contexts, experiences, cultures, and identities? We also find the practicalities of responsive "cartographic" pedagogies to be understudied in CS education. For example, what tensions do CS educators encounter as they foster rhizomatic learning within formal educational systems? What reflective approaches do successful CS educators employ to evaluate their rhizomatic pedagogies? What tensions might CS educators face when facilitating rhizomatic learning "at scale" for large numbers of students?

Many of the questions we have posed in this paper are difficult to address within formalized education systems, especially those driven by neoliberal economics which privilege tech industry profit over the situated needs of educators and learners [16]. Rhizomatic learning calls educators to radically embrace learners' goals, needs, interests, and desires by creating new fields of inquiry at the intersections of their experiences—new interdisciplines between learners, the educator, and the CS education community. We hope that by embracing the difficult and ambiguous challenges associated with practicing rhizomatic teaching and learning, computer science teachers, learners, and researchers might continue to broaden the field by creating space for more diverse teaching and learning practices situated by learners' intersectional identities.

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