

Appalachian Ingenuity and the Need for Rurally Sustaining Computational Thinking Pathways

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ABSTRACT

Our research-practice partnership with two school districts in Eastern Kentucky has created a rurally sustaining computational thinking (CT) pathway. In this paper we share our project's operational understanding of the concept of rural sustainability in the context of CT pathways. We posit that an effective CT pathway for rural communities must be firmly rooted in their cultural wealth, funds of knowledge, and socioeconomic priorities. Moreover, it should empower students to draw upon their own innovation heritage, leveraging CT as a tool to identify and address community challenges. Emphasizing the necessity of incorporating rural contexts into discussions on equitable access to computing education, our conceptualization provides insights into how policy and research can contribute to this important goal.

CCS CONCEPTS

• Social and professional topics ~ Professional topics ~ Computing education ~ Computational thinking • Social and professional topics ~ Professional topics ~ Computing education ~ K-12 education

KEYWORDS

Computational thinking, Computer science, Rural education, Culturally sustaining computing

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1 Introduction

Resilient. Regenerative. Innovative. Ties to family and place. These are qualities that teachers in Eastern Kentucky identify as part of their culture and heritage. After a workshop that focused on computational thinking (CT) and project-based learning (PBL), one of the Eastern Kentucky teachers reflected, “I, along with my peers, have borne witness and been impacted by makers—people who live on the edge of disruption and choose to use it as an agent.” This belief, that she, her fellow educators, her

students, and their families were an innovative people, lighted her imagination about what her students’ futures could be and how she could shape their educational experiences to achieve that future. This connection of teaching practices like PBL and CT and Appalachian Ingenuity, a local term introduced to us by our district partners that refers to the ways that people in Eastern Kentucky and Appalachia have innovated solutions to myriad problems they have encountered while living in a harsh landscape, became the focus of our research practice partnership (RPP).

The potential importance of connecting CT to Appalachian Ingenuity became apparent during our second year when we observed teachers to be excited to learn about CT, but also seemed to consider it a “nice-to-have” rather than a “must have.” Students might enjoy the CT lessons taught in a project-oriented way (e.g., animate an event of choice using Scratch) but not necessarily consider it important, related to who they are, or have usefulness beyond getting a good grade. Together our team of researchers and practitioners also realized that CT education in Appalachia is likely to be insufficient as a driver of skill and workforce development if we do not also attend to cultivating the type of mindsets we find in those who embody Appalachian Ingenuity — something that K-12 teachers are in a unique position to impact equitably and at scale. Continuing to build CT pathways in Eastern Kentucky, we sought to bring together educators in Eastern Kentucky to imagine a future in which their students are engaged with solving community problems, grounded in their heritage as innovators, and have a deep understanding of CT. A district leader crystallized the ideas that became our focus saying:

Appalachian Ingenuity and how we capture and perpetuate that, for me that’s the biggest driver that has come out of what we’ve done in the past 3 years. It takes [computer science] from novelty to actual change, and it ties it directly to the people on the ground.

Our RPP sought to respond to these calls to build not only a CT pathway for the two Eastern Kentucky districts, but one that is rurally sustaining by grounding the work in Appalachian Ingenuity. This work over the past five years has illuminated the importance of place and context when creating a CT pathway and the particular challenges with bringing inclusive and equitable computing education to rural areas. It has led us to believe that the creation of rurally sustaining CT pathways

benefits from being led by the communities they will serve and incorporating five specific elements described below.

2 Positionality

The three research-side partners currently on this project bring passion and experience for culturally responsive-sustaining CT education and a commitment to centering voices of educators and students in their work. They identify as women (Asian, white, and white and Indonesian), have K-12 teaching experience, and currently live in metropolitan areas. The practice-side project leaders currently include five district leaders (all from Eastern Kentucky) and a retired teacher, as well as a former district leader from Pennsylvania who grew up in rural West Virginia. All bring passion for Eastern Kentucky's community and heritage, and hope to support students to address any life problems that may come their way and be able to live a good life in Eastern Kentucky if they so wish. While the Insider-Outsider paradigm for considering the positionality of researchers has its limitations [5], we have found that having an RPP composed of researchers and practitioners that represent both Insider (members of rural communities in Eastern KY) and Outsider (non-members of rural communities in Eastern KY) has created several advantages in our project. We explore these advantages further in section 6.

3 The Need for Rurally Sustaining Pathways

While our RPP initially focused on developing a CT pathway that built student confidence and aligned with local aspirations of economic revitalization, the need for the pathway to be rurally sustaining emerged. Two main challenges of rural areas guided our work: out-migration and deficit based portrayals of the region. Out-migration refers to when skilled and educated individuals leave an area due to a perceived lack of opportunities [10]. In a study with Berea College in Kentucky, 25% of graduates reported it was unlikely they would live in Central Appalachia, the region in which the two districts are located [14]. Factors that influence out-migration include the likelihood of getting a desired salary, opportunities for career advancement, and opportunities for an interesting and challenging job [14]. Keeping the issue of out-migration front-of-mind when developing a CT pathway is important to ensure that CT isn't solely presented as a "way out" of rural communities but as a skill that can be used to find and create well-paid, growth-oriented, innovative businesses within rural communities as well.

We have focused on promoting positive narratives of rural communities, in part to counter negative stereotypes frequently perpetuated by media [3]. Community leaders supporting our project have emphasized the urgency of fostering a more accurate and asset-based narrative, particularly among young students, as this is crucial not only for their mental well-being but also for sustaining economic vitality. The success of new job opportunities and initiatives for job creation in Eastern Kentucky hinges on the residents' belief in their own capability and the

region's worthiness of success. Thus, our project has strived to avoid introducing CT - which unmistakably originates from non-rural contexts - as the sole and definitive valuable skill to acquire, and placed significant emphasis on introducing narratives that are supportive of rural sustainability alongside the acquisition of CT skills.

4 Elements of a Rurally Sustaining CT Pathway

In our work, we defined a rurally sustaining CT pathway as a CT pathway that incorporates rural culture and ways of being. A CT pathway is an articulation of a computing course-of-study that is consistent across classrooms, cumulative from year to year, and competency-based [5]. While CT has myriad characterizations [4], we have mainly focused on decomposition, algorithmic thinking, automation, and data practices due to their alignment with CT Kentucky state standards. The development of a rurally sustaining CT pathway builds on the prior work of culturally responsive-sustaining computing. This includes connecting students' cultural assets to CS/CT content and skills [1], allowing students to reflect on and challenge the status quo in computing using computational skills [11], and drawing upon heritage practices [12] [8], and culture [4] in computing work. In terms of what it means for a CT pathway to be rurally sustaining, our initial conception was simply that the pathway needed to be respectful of rural culture and ways of being. We have sought to build on this approach by centering rural cultural wealth [2] and through ongoing discussion with our practice-side partners, articulating these five elements that we believe should be included when building a rurally sustaining CT pathway:

- Connect CT education to rural communities' socioeconomic priorities and aspirations for future economic possibilities.
- Connect CT to rural communities' cultural wealth [16] such as connection to place, family, faith, and community, perseverance, collaboration, resourcefulness, and pragmatism.
- Incorporate students', teachers', families', and local industries' funds of knowledge [9] such as tinkering, making, fixing, automating, crafting, cooking, mining, and music production with CT practices and skills
- Leverage CT to help address community problems as identified by community members, rather than outside researchers or individuals.
- Reflect on the impacts of computing technologies on rural societies.

4.1 Connect CT Education to Rural Communities' Socioeconomic Priorities and Aspirations

Many rural areas have front-burner priorities around economic and sociocultural sustainability (including addressing unemployment and out-migration). Given how scarce resources can be in rural areas, it is especially important for CT education

initiatives to consider local priorities and visions for the future. It behooves CT pathway initiatives to connect with community leaders beyond the education sector to envision shared community priorities, and specific ways in which CT education may support them. After the collapse of the coal industry in Eastern KY, economic redevelopment was a large community priority that motivated CT education. Conversations about the importance of computing-related skills and jobs to the region were underway in the business sector when school leaders started thinking of implementing CT education at the K-8 level. Also underway were several arts and social initiatives to retell and newly create asset-based narratives about Appalachia by Appalachians.

Within our project, business and arts leaders have been invited to give “inspire talks” and host teachers on field trips to their organizations. These interactions have helped education leaders not only to conceptualize key elements of several K-8 CT education initiatives, but also helped better explain to teachers, parents, and students why CT skills and practices were important to learn, from the perspective of local social and economic priorities. Business leaders have taught us, for example, that there is a wider variety of local opportunities that leverage CT skills than many of us initially imagined, including but not limited to agricultural technology, software development, and media and communications. Both business and arts leaders have emphasized the importance of broader skills and mindsets such as having a problem-solving orientation (e.g., perceive problems as opportunities), having pride in who they are, and where they are from, and valuing community well-being and support. Our improved understanding of regional priorities has broadened our CT education initiative to emphasize “complex problem-solving” [7] and narrative development, and have CT be introduced as skills that are often helpful (although not sufficient nor always necessary) towards these goals.

4.2 Connect to Rural Communities’ Cultural Wealth

Crumb et al. [3] recently coined “rural cultural wealth” as including rural resourcefulness, rural ingenuity, rural familism, and rural community. Our project likewise had examined Yosso’s [16] article on “Whose culture has capital?” [6], in conjunction with other sources [7] [13] [10] and noticed that Appalachia is rich in many of the types of community wealth that Yosso describes, including but not limited to familial capital (or kinship), aspirational capital, linguistic capital, and resistant capital. These assets provide an essential backbone for innovation, including when building a rurally sustaining CT pathway. Identifying connections to these assets also provides an entry point for educators, parents, and students for whom CT practices and skills can seem remote.

The field trips and “inspire talks” previously mentioned made these connections concrete for teachers. For instance, one “inspire talk” was with a Kentucky native who created a regional awards event celebrating Appalachian arts and entertainment who spoke to the teachers about how she was inspired to create something that celebrated Appalachian culture, countered

stereotypes, and simultaneously made an economic contribution to the region. The event coordination processes referenced CT, such as breaking down this large project into smaller, manageable pieces (decomposition) as well as the algorithmic and automated processes needed to develop the voting process for the awards. At the same time, this work drew deeply on regional cultural wealth such as rural resourcefulness (taking actions to overcome socio-contextual adversities), and rural ingenuity (inventiveness). Working with district partners to identify community stories and examples like this operationalizes CT skills and practices for teachers while also highlighting and building upon the wealth in their community.

To foster these skills, our educator partners have focused on developing CT learning experiences that are embedded within problem solving and teamwork. They emphasize programming for good rather than for the sake of creating something new or flashy. For example, elementary students noticed that some of their classmates with special needs were not able to participate in school-based performing arts shows. Students brainstormed many different solutions and as a result developed an interactive sound board that students with special needs could operate to produce a variety of sounds and words for the performance. This application of CT skills and practices was firmly founded in the cultural wealth of the community such as rural ingenuity, rural familism, and rural resourcefulness. A rurally sustaining CT pathway should position teachers to offer students CT learning experiences that connect CT with similar cultural assets.

4.3 Incorporate Funds of Knowledge

When developing rurally sustaining CT pathways, it is also important to incorporate students’, teachers’, and families’ funds of knowledge. Funds of knowledge refer to knowledge and skills that are essential for daily living, that connect to home cultures, and that may not be typically celebrated in the culture of schooling [6]. One way that our district partners encouraged teachers to connect their funds of knowledge to CT was to ask teachers to bring in artifacts that represented Appalachian Ingenuity in their own lives. Teachers brought in examples of tinkering, crafting, cooking, making, and fixing that highlighted Appalachian Ingenuity in their own homes and in their childhood homes. The objects showcased skills that the teachers, their parents, and their ancestors had developed that were an everyday part of life. Several of these artifacts also connected to CT practices. For instance, one teacher brought in a simulated hornet’s nest made from a paper bag that her grandmother would hang from the porch to keep actual hornets away. This excellent example of abstraction could be used to show how it is important to determine the key elements of something and ignore unnecessary details. Although it was not a real hornet’s nest, the shape and color were enough to deter real hornets from building a nest and disturbing their porch space. As they were sharing, the teachers recognized that these funds of knowledge weren’t being passed on to most of the students of today and that there may be value in celebrating the heritage and innovation of Appalachian Ingenuity in the region to both root CT learning experiences to family and community and to

counter negative stereotypes about the Appalachian region and Eastern Kentucky.

Establishing a connection for teachers between their funds of knowledge and CT opens the possibilities for lessons and activities that connect students' funds of knowledge with CT. One project that highlights this connection is a group of elementary students who are building on their knowledge of gardening and agriculture to develop a moisture sensor that could automate irrigation. Recognizing how challenging it is to anticipate when crops need water and accounting for the desire to only water when necessary, students are designing, coding, and iterating on an automated system. Looking for CT projects that help students connect to their families' funds of knowledge ensures that CT isn't done in isolation or without valuing the skills and knowledge that are integral in their community.

4.4 Address Community Problems

A key aspect of Appalachian Ingenuity that needs to be brought into CT pathways is the connection to and appreciation for place and how CT can be relevant to addressing challenges faced by community members. The districts we worked with connected CT with PBL which allowed teachers to see how they and their students could approach a community problem and bring in CT to investigate, act on, or share information about the problem. One of the "inspire talk" speakers was a former coal miner who now works as a developer at a local software development startup. He talked to the teachers about an app the company developed with students in Eastern Kentucky to improve communication between students and school staff, specifically to address mental health, bullying, and school safety concerns. He and the students identified this community concern and solved the problem by creating an app. This presentation by a local community member that was directly using CT to solve a community problem helped teachers see how CT might be a tool to help students feel empowered to tackle problems they see in their communities.

We saw this connection to and appreciation for place play out in several different projects. In one project, students worked on a way to better sort glass materials for recycling. Recognizing the importance for their community to better identify and reuse materials and seeing how innovators of the past tinkered and repurposed materials, students designed a better sorter. To do so they have engaged with CT in numerous ways: decomposition of the larger problem into smaller pieces, algorithmic thinking to design the sorting process, and debugging the algorithms and automation to get the sorting process to work properly. This last step has required students to lean into perseverance and problem solving as the motor keeps jamming and sticking. By positioning CT as a practice that may enhance community problem solving, students and teachers can see that CT is one of many ways they can create solutions to challenges in their community.

4.5 Discernment Regarding the Impact of Computing on Rural Societies

Practicing caution and developing discernment regarding the negative as well as positive impacts of computing is an important aspect of a rurally sustaining CT pathway. Technology can bring its own culture [1] and values that may differ from that of rural areas. For example, the value of "Move fast and break things," famously the motto of Facebook at its founding, may not be as useful or desirable in rural areas where resources are precious and neither easily replaced nor fixed once broken.

The relationship between emerging technologies, culture, and values is complex. One teacher talked about the change in culture that Amazon delivery has brought to the region. "Everything is now, now, now. ... How do you convey to kids who are literally growing up in the 'now society' that you do have to persevere? You just can't Amazon everything." This doesn't imply that all technological conveniences (and their designers) from the cities need to be shunned or attacked - far from it. But it does suggest that rural educators may want to be cautious about what they introduce to students about computing technologies, and help students practice similar caution and discernment when faced with decisions to adopt new practices or ideas.

Our project has promoted prudence and discernment among educators by encouraging ongoing open dialogue that delve into why they teach, why education is important for their students and the community, the relative strengths of the region, and how CT fits among these. We have also introduced teachers to local professionals who use CT while centering Appalachian heritage and cultural wealth. Such activities create space for rural educators to conceptualize and teach computing in ways that make sense to their locale and recognize when some aspects of the messaging or lesson plan doesn't feel quite aligned with their priorities.

The way we imagine K-8 students could develop caution and discernment about computing is similar. We can provide students with permission and strategies to pause and assess situations where technology and computing create tensions with rural cultural wealth and funds of knowledge. Students may need explicit instruction that it's okay (and often wise) to not agree with something right away, and they can take the time to assess and choose to disengage or push back as a result.

5 Limitations

As we refine what a rurally sustaining CT pathway is and how it can serve the communities of Eastern Kentucky, there are several aspects of the work that we have not yet explored. While we have begun to unpack commonalities in the cultural wealth and funds of knowledge of teachers and students in Eastern Kentucky, we know there is also great diversity within the community. Understanding how Appalachian Ingenuity both captures and excludes some members of the community will be important in future work. For instance, to what extent do students and teachers that identify as part of the LGBTQ+ community feel connected to faith and community as currently defined in these pathways? And while business leaders and

educators highlight the importance of a rurally sustaining pathway grounded in these five elements, do all families (particularly families from different socioeconomic levels) find resonance in these five elements? Our work does not currently explore different intersectionalities of race, identity, and economic status with rurality. Yet we hope to determine how to integrate the diversity of Appalachian Ingenuity in future iterations of the CT pathway and incorporate more voices in the conceptualization of our pathway as our RPP continues.

6 Implications for Policy and Research

One of our community partners says “People can’t work toward a future if they can’t see it first. People don’t want to design a future that they aren’t in. People need to feel a sense of agency or permission to help shape that future.” These three tenets are critical to policies related to CT and rural communities. CT needs to be operationalized in a way that students, educators, and communities see that it is connected to their lives and heritage and that they have a role in shaping that future. Policy decisions directly impact if and how that work can happen. We recommend funding and research designs that support co-design within RPPs to develop rurally sustaining CT experiences for students. We have found that the relationship of an internal team member - a teacher, administrator, or coach - that is embedded in the rural community, with an external team member - a researcher, curriculum specialist, or academic - from outside of the rural community, is beneficial to developing curricular materials that are grounded in rural cultural wealth while incorporating CT. By working in collaboration, external partners bring a new lens through which to view everyday occurrences. In our partnership, our district and community partners have noted how our research team has celebrated skills and mindsets that feel mundane or ordinary to them and highlighted how these are community and cultural assets. As long as the external partners consider the five elements of a rurally sustaining CT pathway outlined in this paper, and others that future RPPs might find important, the dynamics of this external/internal partnership can develop a pathway that is meaningful and purposeful for the rural community. Policy that provides funding opportunities for this type of co-design within RPPs to take place would help to develop CT curricula that is rurally sustaining.

We also make a larger call here for policy that supports the funding of collaborations between schools and local thought leaders in economic development and governance. In this RPP, it was the connection between the schools and local leaders that really drew out aspects of rural culture that were significant to Appalachian Ingenuity. Presentations, visits, and open conversation among teachers, school leaders, and business leaders led to deeper understanding of how CT could look and feel to best continue economic renewal in the area. Emphasizing problem-solving that sees challenges in the community as opportunities and considering how to build those mindsets alongside specific CT skills like decomposition and algorithmic thinking was central to the ongoing success of this project.

Policies and research that recommend and provide guidance for how rural school districts can create a base of support, interest, and inspiration for innovation could result in lasting change for rural schools and their communities.

In addition to connecting with local communities to identify priorities for CT work, we advocate for professional development (PD) that forefronts cultural wealth and funds of knowledge that teachers may see how their heritage connects to CT. While organizations and researchers advocate for more PD and certification of CT teachers in rural areas [2] [15], we add to that call by suggesting that just as a one-size-fits-all curriculum is not appropriate for CS/CT students, one-size-fits-all PD development is not appropriate for all CS/CT teachers. Policies that provide funding for and research that supports CT professional learning should incorporate recommendations for tailoring professional learning for rural schools by connecting to rural cultural wealth and local funds of knowledge.

Rural communities are facing significant economic and cultural challenges, but these communities also have a long tradition of innovation and ingenuity that can be drawn on to address these challenges and can envision a future for their students and community. As one of our teachers reflected, the “inspire talks” resulted in “goosebumps and tears as we think about what opportunities are in our region and what possibilities are on the horizon.” Developing rurally sustaining CT pathways that align with socio-economic priorities and aspirations and build on cultural wealth and funds of knowledge are essential to CT education and ensuring that all students, including those in rural areas, have access to powerful learning experiences in computing.

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