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Abstract

We highlight the impacts of inequitable distributions of resources across geographies, structural challenges faced in partnerships with rural schools, and the importance of asset-based arguments to recognize and engage with systemic challenges. Precollege engineering education often focuses on engaging students and teachers hands-on with novel technologies and experiences that frequently distract from systemic inequities, particularly pertaining to place. Given national efforts in rural STEM education, there is a need to recognize important contextual factors influencing precollege engineering education. Through a lens of working with rural Appalachian schools, we hope to challenge practices and assumptions in precollege engineering education.

Keywords

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ARTICLE

Reconciling Modern Engineering Education with the Everyday of Rural Schools and Youths

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Abstract We highlight the impacts of inequitable distributions of resources across geographies, structural challenges faced in partnerships with rural schools, and the importance of asset-based arguments to recognize and engage with systemic challenges. Precollege engineering education often focuses on engaging students and teachers hands-on with novel technologies and experiences that frequently distract from systemic inequities, particularly pertaining to place. Given national efforts in rural STEM education, there is a need to recognize important contextual factors influencing precollege engineering education. Through a lens of working with rural Appalachian schools, we hope to challenge practices and assumptions in precollege engineering education.

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The engineering education field continues to grapple with contextual and systemic factors that impact K–12 education in the United States. Despite significant long-term efforts to broaden participation and work toward equity in the STEM workforce through, for example, research, curriculum development, and outreach activities, institutionalized barriers to access remain. It is vitally important that researchers and practitioners in engineering education continue to prioritize exploring how marginalization and exclusion remain

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embedded in educational policies and practices that ultimately impact who can become and flourish as engineers. This focus is particularly relevant for precollege engineering education work that might engage with rural students, schools, and communities. Therefore, the purpose of this essay is to call out misalignments between what we feel is (or is not) being discussed in the field of engineering education with respect to issues facing rural communities and their youths, teachers, and school systems.

As a whole, there is limited research that engages with both rural and STEM educational contexts (Harris & Hodges, 2018). As far as we are aware, the engineering education community has rarely explicitly engaged with rural contexts and associated place-based considerations in research, and therefore we seek to highlight emergent insights from our own experiences. It is further important to note that while the word "rural" might conjure up many images and stereotypes, including on dimensions such as race, ethnicity, class, gender, and politics (Azano et al., 2020), the term "rural" does not carry monolithic distinction.

This work is informed by prior and current research with rural Appalachian schools and community members (Grohs et al., 2020) as well as theoretical and conceptual frameworks that are focused on issues of geography and spatial justice (Biddle et al., 2019; Soja, 2010). More specifically, we have together worked extensively to engage with and understand the specific contexts of rural engineering education as it relates to our work in Appalachian southwest Virginia (Grohs et al., 2020; Schilling & Grohs, 2024).

In the following sections, we make three key claims that we hope will help the field continue to reflexively grow in its understanding and approaches to broadening participation and equity. We highlight these misalignments through a lens of rurality and spatial justice while also reaffirming the vital work being led by other scholars in engineering around ways in which racism, sexism, and classism are entrenched in engineering education; indeed, engineering education in rural spaces too must grapple with how those factors manifest in this context. The three claims that we unpack in greater detail below are (1) rural areas are often forgotten or ignored in (engineering) education research and practice, (2) resources alone are not sustainable infrastructure, and (3) highlighting systemic problems is consistent with an assets-based approach. Engaging with rurality in engineering education research and practice is crucial to the future of our field and to being responsive to the needs of students and their communities, especially as efforts to grow the workforce by focusing on rural economic and regional development and rural STEM education research are prioritized by the U.S. government and funding agencies (Rural STEM Education Research Act, 2021).

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RURAL AREAS ARE OFTEN FORGOTTEN OR IGNORED IN (ENGINEERING) EDUCATION RESEARCH AND PRACTICE

Much precollege engineering education work relies heavily on various forms of outreach and integrating engineering into existing structures in science classrooms and schools. For example, popular outreach activities include robotics and design teams (Brophy et al., 2008; Sneider & Ravel, 2021), and we rely heavily on standards that support the integration of engineering concepts such as the Next Generation Science Standards (National Research Council, 2013). Additionally, teacher professional development is often part of the resources needed for teachers to gain the knowledge and experience necessary to effectively integrate some of these standards (Zinger et al., 2020). For these things to work, there seems to be an underlying assumption that all schools have access to the same resources to support these efforts. Through the intentional efforts of educational policy and practice to create more level playing fields in education, such as the Every Student Succeeds Act (Penuel et al., 2016), it may be fair to assume that all schools should have the same access to these resources and opportunities. However, this is not the case. Given various complexities of and policies for school funding, such as per pupil funding and relying on the community tax base (Koricich et al., 2018), there are schools in many places that may face challenges with implementing some engineering curriculum or outreach. For example, schools with lower student enrollment and schools in communities experiencing poverty may not have access to the same resources as schools with larger student enrollment and schools in wealthier communities.

In rural places, these challenges are particularly relevant (Brenner, 2018). Because rural schools often do not have as many students and because many rural communities experience poverty (Brenner, 2021; Tieken, 2021), rural schools often face funding challenges that would severely impact access to the type of outreach and engineering curricular integration that is common in precollege engineering education work (Harris & Hodges, 2018). Additionally, rural places are often farther from institutions of higher education, which often do have the structural support and resources to engage with schools. However, existing research shows that this distance from colleges and universities impacts rural students' touch points with outreach from these institutions, which can then impact rural students' perceptions of available career pathways and opportunities (Matusovich et al., 2020).

While we suspect that there are ongoing efforts in the precollege engineering education community to support rural students, rarely do we see this context addressed in research that is shared broadly (i.e., through journal articles and conference

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papers). As rural education scholars would argue, the rural context does matter for the work of educators; however, simply mentioning that the study takes place in a rural setting does not provide enough context. Kingsolver (2017) reminds us that what it means to be rural in one place is not the same as what it means to be rural in another. Therefore, explicitly describing the context of our work as engineering educators is crucial. Questions around what type of school our work takes place in (e.g., what type of funding impacts the school, school locale categories as defined by the National Center for Education Statistics), and what makes the context specifically rural can be addressed using geographic, demographic, or other more nuanced descriptions such as those that could be provided by community members (Biddle et al., 2019; Coladarci, 2007).

RESOURCES ALONE ARE NOT SUSTAINABLE INFRASTRUCTURE

Pertaining to outreach and engagement as a means to work toward equity, we have concerns that much of the precollege engineering education work has focused on schools that are convenient in terms of geographic proximity and well-resourced schools with existing infrastructure to support willing and capable teachers. While from a practical standpoint it makes sense to leverage existing structures that support this work rather than creating the structure from scratch, we wonder what impact is actually made toward achieving equity in engineering education when the schools we work with already have pipelines for students to pursue engineering. For example, we know that students from schools that likely have strong STEM education infrastructure and students from areas where there is strong STEM-related human capital are more likely to pursue postsecondary engineering degrees (Knight et al., 2020).

Additionally, rural schools often face challenges in recruiting and retaining teachers. As Zinger et al. (2020) identified, in rural areas a school might have only one science teacher, which can create isolating experiences and limited opportunities to connect with peer teachers. From our own experiences, sometimes teachers who do not even have training in STEM are placed in science classrooms to fill vacancies. Scholars have identified that it is challenging to recruit teachers to rural places (Zinger et al., 2020), especially if the teachers are not from rural places themselves, because of the geographic isolation, resource access, and pay differences between teaching in rural versus nonrural areas (i.e., nonrural teachers often make more money). In light of the teacher shortage fueled by COVID-19, the underpaying of educators, and the de-professionalization of the teaching profession, rural schools have been hit hard.

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From our ongoing work, we have found it particularly challenging to establish connections with teachers and district-level STEM coordinators in rural places. In many instances, these positions are vacant or teachers are so overworked and overwhelmed by other priorities that they are not able to take on additional work. Therefore, we have questioned how we can better reach educators who may be interested in partnerships and outreach but may need more support to work toward systemic infrastructure.

Furthermore, we observe that the existing partnership model seems to favor the implementation of activities and design-based research without the need to invest in new organizational structures to support students and teachers. For example, much work seems to focus on novel activities with different technologies that are developed from grants that may provide resources such as 3D printers or projects such as the egg drop that lack personal and social relevance (McComas & Burgin, 2020). While these activities may provide something new for students, the shallowness of these types of engagement do not necessarily lean toward infrastructure. Additionally, if schools do not have teachers with time, resources, and support to utilize different technologies, we believe that many resources such as 3D printers remain unused or are kept around for show. Therefore, we recommend that precollege engineering education researchers grapple with what it means to partner with schools, teachers, and students and whether we are really reaching the teachers and students we hope to reach. If we are not, what are the challenges, and what does a successful partnership look like in our field to achieve goals around equity?

We argue that a different approach to partnership is needed, one in which engineering education resources serve as the facilitators to support a sustainable structure for STEM engagement. In this type of partnership, we would expect that engineering education researchers would identify the specific place-based contexts in which the students, teachers, and schools exist, along with activities that are responsive and appropriate for a given rural community (Schilling & Grohs, 2024). For example, we have found that doing the work to understand rural communities and build relationships with rural schools, teachers, students and industries is incredibly important for opening the possibility of building and strengthening rural STEM education infrastructure. We have found that the resources that engineering education obtains from institutions of higher education and grant funding, including time, money, and physical resources, enable us to serve as bridges for teachers and schools that might need or want access to structures that can support efforts to introduce students to engineering. Oftentimes, this also means placing the needs of partnership and collaboration before research priorities for meaningful engagement and being responsive to the needs of rural contexts (Grohs et al., 2023).

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HIGHLIGHTING SYSTEMIC PROBLEMS IS CONSISTENT WITH AN ASSETS-BASED APPROACH

More recently in the field of engineering education, we have emphasized the importance of using asset-based theories in our research and practice (Martin & Wendell, 2021). These theories often include but are not limited to community cultural wealth (Yosso, 2005), funds of knowledge (Moll et al., 1992), and culturally relevant teaching (Ladson-Billings, 1995a, 1995b, 2014). These theories are incredibly important, as they seek to acknowledge students' and communities' culture, values, and knowledge that can provide enriching educational experiences that are not necessarily valued in current educational systems while challenging the existing structure of those systems, which can be affirming for students and communities who have been historically marginalized.

While we recognize the critical importance of these theories in our field to reframe the way we discuss students and communities, we have also observed and experienced that using assets-based theories and approaches means we cannot discuss systemic issues or actual issues that people experience. The primary danger of deficits-based thinking is that individuals and communities are blamed for conditions they experience or that people are simply reduced to a problem. However, we feel that having conversations while intentionally ignoring or not discussing systemic problems (in an effort to avoid falling into deficits-based perspectives) can be more dangerous. By not discussing issues or by being resistant to explicitly naming problems, we are not able to move forward toward our shared goals and run the risk of continuing to perpetuate problems.

There is a critical balance that must be struck between creating opportunities for critique and building hope and action toward the future in work with rural communities (Freire, 2018; Giroux, 1992; Gruenewald, 2003a, 2003b). Assets-based approaches specific to rural contexts, such as rural literacies (Corbett & Donehower, 2017; Donehower et al., 2007; Donehower, 2021; Edmondson, 2003), focus on the need for place-making in socially constructed places. As a part of rural place-making, members of rural communities should be encouraged to actively identify problems and engage with them as a way to work toward engaging in the future of sustaining rural communities and justice for rural communities. Rural literacies in particular contradict commonly held views of rural places as "deficit spaces of inadequate educational productivity" (Corbett & Donehower, 2017, p. 9). Grounding our work in the systemic forces that impact the problems rural communities experience (e.g., energy-related resource extraction, lack of educational funding, school closures, and economic disinvestment) is not inherently deficit-based thinking but can actually open up possibilities, as the act of problematizing an issue can be empowering as

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individuals recognize the influence of myriad micro-, meso-, macro-, and exosystem factors that comprise the issue (Schilling & Grohs, 2024). For engineering educators who engage in research and outreach, we must be able to identify and engage with systemic issues while recognizing the lived experiences of the people with whom we partner in a way that honors reality.

CONCLUSION

By highlighting our claims and concerns, we hope to encourage precollege engineering education researchers to engage more deeply with the place-based contexts that impact our work. Our claims and concerns come from a context that has been largely informed by the work we have done with rural schools, teachers, and students. Although we suspect that the things we have highlighted here are common across many contexts, we write from our lens of specifically highlighting aspects of spatial justice in rural places as they pertain to engineering education. We hope that we can spark conversation with the community to consider more deeply what a contextualized place-based partnership with schools and teachers can mean for equity in education, particularly engineering education.

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REFERENCES

Azano, A. P., Brenner, D., Downey, J., Eppley, K., & Schulte, A. K. (2020). *Teaching in rural places: Thriving in classrooms, schools, and communities*. Routledge. https://doi.org/10.4324/9781003106357

Biddle, C., Hall Sutherland, D., & McHenry-Sorber, E. (2019). On resisting "awayness" and being a good insider: Early career scholars revisit Coladarci's swan song a decade later. *Journal of Research in Rural Education*, *35*(7), 1–16. https://doi.org/10.26209/JRRE3507

Brenner, D. (2018). Rural educator policy brief: Rural education and the Every Student Succeeds Act. *Rural Educator*, *37*(2). https://doi.org/10.35608/ruraled.v37i2.271

Brenner, D. (2021). Toward a rural critical policy analysis. In A. Price Azano, K. Eppley, & C. Biddle (Eds.), *The Bloomsbury handbook of rural education in the United States* (pp. 30–42). Bloomsbury Academic. https://doi.org/10.5040/9781350172036

Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P–12 classrooms. *Journal of Engineering Education*, *97*(3), 369–387. https://doi.org/10.1002/j.2168-9830.2008.tb00985.x

Coladarci, T. (2007). Improving the yield of rural education research: An editor's swan song. *Journal of Research in Rural Education*, *22*(3), 1–9. http://jrre.psu.edu/articles/22-3.pdf

Corbett, M., & Donehower, K. (2017). Rural literacies: Toward social cartography. *Journal of Research in Rural Education*, *32*(5), 1–13. https://jrre.psu.edu/sites/default/files/2019-08/32-5.pdf

Donehower, K. (2021). Rural literacies and rural identities. In A. Price Azano, K. Eppley, & C. Biddle (Eds.), *The Bloomsbury handbook of rural education in the United States* (pp. 187–195). Bloomsbury Academic. https://doi.org/10.5040/9781350172036

Donehower, K., Hogg, C., & Schell, E. E. (2007). *Rural literacies*. Southern Illinois University Press.

Edmondson, J. (2003). *Prairie town: Redefining rural life in the age of globalization*. Rowman & Littlefield.

Freire, P. (2018). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). Bloomsbury. (Original work published 1968)

Giroux, H. (1992). *Border crossings: Cultural workers and the politics of education*. Routledge.

Grohs, J. R., Gillen, A. L., Matusovich, H. M., Kirk, G. R., Lesko, H. L., Brantley, J., & Carrico, C. (2020). Building community capacity for integrating engineering in rural middle school science classrooms. *Journal of STEM Outreach*, *3*(1), 1–12. https://doi.org/10.15695/jstem/v3i1.01

Grohs, J., Schilling, M. R., Laney, J., Kirk, G., & Matusovich, H. M. (2023). School-industry-university partnerships to support engineering pathways for rural youth. In S. L. Hartman & B. Klein (Eds.), *Middle of somewhere: Rural education partnerships that promote innovation and change*. Harvard Education Press.

Gruenewald, D. A. (2003a). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal, 40*(3), 619–654. https://doi.org/10.3102/00028312040003619

Gruenewald, D. A. (2003b). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*(4), 3–12. https://doi.org/10.3102/0013189X032004003

Harris, R. S., & Hodges, C. (2018). STEM education in rural schools: Implications of untapped potential. *National Youth at Risk Journal, 3*(1), 3–12. https://doi.org/10.20429/nyarj.2018.030102

Kingsolver, A. (2017). Practical resources for critical science education in rural Appalachia. *Cultural Studies of Science Education, 12*(1), 219–225. https://doi.org/10.1007/s11422-016-9755-3

Knight, D. B., Grohs, J. R., Bradburn, I. S., Kinoshita, T. J., Vaziri, S., M. Matusovich, H., & Carrico, C. (2020). Illuminating inequality in access: Variation in enrollment in undergraduate engineering programs across Virginia's high schools. *Journal of Engineering Education, 109*(4), 665–684. https://doi.org/10.1002/jee.20352

Koricich, A., Chen, X., & Hughes, R. P. (2018). Understanding the effects of rurality and socioeconomic status on college attendance and institutional choice in the United States. *Review of Higher Education, 41*(2), 281–305. https://doi.org/10.1353/rhe.2018.0004

Ladson-Billings, G. (1995a). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3), 160–165. https://doi.org/10.1080/00405849509543675

Ladson-Billings, G. (1995b). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465–491. https://doi.org/10.2307/1163320

Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: A.k.a. the remix. *Harvard Educational Review, 84*(1), 74–84. https://doi.org/10.17763/haer.84.1.p2rj131485484751

Martin, L., & Wendell, K. B. (2021). Reflections on asset-based pre-college engineering education to promote equity: An introduction to the special issue. *Journal of Pre-College Engineering Education Research (J-PEER), 11*(1), 42–45. https://doi.org/10.7771/2157-9288.1325

Matusovich, H., Gillen, A., Carrico, C., Knight, D., & Grohs, J. (2020). Outcome expectations and environmental factors associated with engineering college-going: A case study. *Journal of Pre-College Engineering Education Research (J-PEER), 10*(1), 60–71. https://doi.org/10.7771/2157-9288.1236

McComas, W. F., & Burgin, S. R. (2020). A critique of "STEM" education. *Science & Education, 29*(4), 805–829. https://doi.org/10.1007/s11191-020-00138-2

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice, 31*(2), 132–141. https://doi.org/cbg3gt

National Research Council. (2013). *Next Generation Science Standards: For states, by states*. National Academies Press. https://doi.org/10.17226/18290

Penuel, W., Meyer, E., & Valladares, M. R. (2016). *Making the most of the Every Student Succeeds Act (ESSA)—Helping states focus on school equity, quality and climate*. National Education Policy Center. http://nepc.colorado.edu/publication/ESSA

Rural STEM Education Research Act. (2021). H.R. 210, 117th Congress. https://www.congress.gov/bill/117th-congress/house-bill/210

Schilling, M. R., & Grohs, J. R. (2024). A conceptual model for engineering educators in rural places: Critical reflection and engagement. *Studies in Engineering Education, 4*(2), 201–221. https://doi.org/10.21061/see.97

Sneider, C. I., & Ravel, M. K. (2021). Insights from two decades of P–12 engineering education research. *Journal of Pre-College Engineering Education Research (J-PEER), 11*(2), 63–98. https://doi.org/10.7771/2157-9288.1277

Soja, E. W. (2010). *Seeking spatial justice*. University of Minnesota Press.

Tieken, M. C. (2021). Rural poverty and rural schools. In A. Price Azano, K. Eppley, & C. Biddle (Eds.), *The Bloomsbury handbook of rural education in the United States*. Bloomsbury Academic. https://doi.org/10.5040/9781350172036

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education, 8*(1), 69–91. https://doi.org/10.1080/1361332052000341006

Zinger, D., Haymore Sandholtz, J., & Ringstaff, C. (2020). Teaching science in rural elementary schools: Affordances and constraints in the age of NGSS. *Rural Educator, 41*(2), 14–30. https://doi.org/10.35608/ruraled.v41i2.558