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STEM Teaching and Learning in Rural Communities: Exploring Challenges and Opportunities An Introduction to Volume 12, Issue 2 of TPRE

Janet K. Stramel and **Earl Legleiter**, Fort Hays State University

This special issue of *Theory & Practice in Rural Education* highlights STEM Teaching and Learning in Rural Communities. The articles selected represent both theory and practice and explore the complexities, practices, challenges, and opportunities facing rural schools and universities as they design and implement STEM teaching and learning. Articles from the field have related rural school success stories of how rural districts have overcome challenges to have effective and rich STEM teaching and learning in rural schools.

Keywords: STEM teaching, rural education

This special issue of *Theory & Practice in Rural Education* highlights STEM Teaching and Learning in Rural Communities. The articles selected represent both theory and practice and explore the complexities, practices, challenges, and opportunities facing rural schools and universities as they design and implement STEM teaching and learning. Articles from the field have related rural school success stories of how rural districts have overcome challenges to have effective and rich STEM teaching and learning in rural schools. Article submissions crossed a variety of topics, and three main themes emerged throughout the articles: (1) making STEM teaching relevant, (2) promising practices, and (3) professional development. While rural educators and communities face unique challenges, they can also provide many opportunities such as the knowledge, experiences, and local connections that can strengthen STEM education. When the complexities of rural spaces are acknowledged, collaborative partnerships can bring external and internal assets together to meet those challenges and boost STEM learning and teaching in rural schools.

Located on the Fort Hays State University campus in rural western Kansas is a one room schoolhouse from another century that was disassembled, moved, and rebuilt in 1976. The Plymouth Schoolhouse is symbolic in every way of our educational heritage. Originally built in 1874 in eastern Russell County, Kansas from hard post-rock limestone, it was one of approximately 60 such edifices spread across the county at the turn of the twentieth century. The schoolhouse has student desks of various sizes to accommodate students from grades one through eight who were taught by a single teacher of all eight grade levels. The schoolhouse has lasted more than a century and provides younger generations with a look into our rural educational history.

Figure 1

Plymouth schoolhouse located on the campus of Fort Hays State University



Note: Photo published with permission of Fort Hays State University (<https://www.fhsu.edu/smei/plymouth-schoolhouse/>)

Students in our Rural STEM Teaching seminar course visit the schoolhouse to contemplate what education must have been like a century ago. They examine the gradebook that was left from the classes taught there in 1922, listing the attendance and scores of seven students. They examine textbooks in mathematics, physical science, and biology that were used at the turn of the twentieth century. Students are asked to think about what education must have been like for these students who learned the three Rs in this building. Can they imagine students walking in the wintertime over the snow-covered Kansas prairie for a day of schooling and returning home at the end of the day to their farm chores that must be completed before supper time? They are also asked to think about what education will look like in rural Kansas communities in the future. What will rural Kansas look like 100 years from now?

Carr and Kefalas (2010) describe the undoing of rural America that has been taking place in recent decades in their book *Hollowing out the Middle: The Rural Brain Drain and What it Means for America*. More than 700 rural counties have lost 10% or more of their population since 1980. The young people from these areas that are moving away include the most capable students that head to universities with the excellent education they received in their hometown rural schools. The hollowing out is widespread and debilitating, and as the authors contend, ultimately detrimental not only to the region but to the nation. “What is happening in many small towns—the devastating loss of educated and talented young people, the aging of the population, and the erosion of the local economy—has repercussions far beyond their boundaries. Put simply, the health of the small towns that are dotted across the Heartland matters because, without them,

the country couldn't function in the same way that a body cannot function without a heart" (Carr & Kefalas, 2010, p. vii).

Seminar students read and discuss *Teaching in Rural Places: Thriving in Classrooms, Schools and Communities* (Alanzo et al., 2021). As students read the book, their thinking is challenged about teaching and living in a rural community. They come to understand and reflect on many of the issues that rural students face such as isolation, limited access to resources, poverty, and teacher shortages. Additionally, they come to see rurality as an education inequity in which 8.9 million US students live and learn. Rural schools and communities have been systematically disadvantaged economically, culturally, and politically. Educating students in rural schools is a project of social justice that deserves as much attention as any other issue disadvantaged populations face (Azano et al., 2021). The book invites the readers to "engage in the important work of *remembering* what is strong about rural communities, *restoring* that which benefits rural people and places, *conserving* qualities of rural communities that should be protected, *changing* that which oppresses or divides us and *creating* new innovative ways to help rural communities thrive" (Greenwood, 2013, p. 99).

Those of us who choose to serve rural schools and communities as our calling in life have much important work to do. An important first step in reversing the downward spiral of the rural communities that we care about is to rethink education in small towns (Carr & Kefalas, 2009). Education opportunities must be equitable for all races, language learners, and socioeconomic groups and students must be well prepared to be successful in college should they choose to go. Perhaps most importantly, there must be a more equitable distribution of resources for those students that chose to stay in rural communities so they can compete in a post-industrial economy that is driven by STEM knowledge and skills. The authors in this issue describe their approaches and research that makes a difference for rural STEM education which will shape the future of STEM education into the next century.

STEM Teaching and Learning in Rural Communities: Exploring Challenges and Opportunities: Articles in this Issue

In this special issue of *Theory & Practice in Rural Education*, article submissions crossed a variety of topics, but three main themes emerged: (a) making STEM teaching relevant, (b) promising practices, and (c) professional development. The first three articles are under the theme of making STEM teaching and learning relevant in rural schools. The final four articles include information for professional development for rural STEM teachers. The final four articles provide promising and effective educational practices in rural schools STEM education. As editors of this issue, it is our privilege to provide a brief overview of each article in this special issue.

Research Forum

Integrating a Sustainability Education Model into STEM Courses at a Tribal College: Building Diverse Scientists via Science Identity Development

In this first study, Liliana Caughman (2022) explored the impacts of implementing a Sustainability Education pedagogy in science courses at a tribal college in order to understand student attitudes towards a science and sustainability curriculum. STEM education must be transformed to welcome and support the achievement of Indigenous scholars. Results indicate

that students are receptive to this curriculum and that they have a positive experience in sustainability focused science courses. Tribal Colleges and Universities as well as other institutions of higher learning can use this work to better understand what leads to Indigenous student success in STEM and update pedagogies accordingly.

Co-designing a Rural Research Practice Partnership to Design and Support STEM Pathways for Rural Youth

The process in which local community members came together to support students through the Research Practice Partnership (RPP) is described in this third article. RPPs are long-term collaborations with researchers and practitioners. Srinjita Bhaduri, Quentin Bidy, Colin Hennessy Elliott, Jennifer Jacobs, Melissa Runnel, John Ristvey, Tamara Sumner, and Mimi Recker (2022) describe their findings of developing an RPP that focused on bringing communities together to co-design opportunities for underserved youth in rural communities through a local STEM ecosystem.

Integrating Computational Thinking in Rural Middle School Art Classes in Eastern North Carolina

In this article, Martin Reardon (2022) describes the integration of computational thinking into music and visual arts in three rural school districts who were part of a research practitioner partnership (RPP). Through the RPP, computational thinking was refined and adapted to the rural contexts in collaboration with the teachers. Additionally, an overview of the curricular activities for the visual arts is discussed as well as student perspectives on the concepts and approaches of computational thinking

Rural Secondary STEM Teachers' Understanding of the Engineering Design Process: Impacts of Participation in a Research Experiences for Teachers Program

In the next article, Teresa Shume, Bradley Bowen, Jewel Altimus, and Alan Kallmeyer (2022) explore STEM teacher professional development which is not equally available to educators in rural districts. The study investigates the impacts of a Research Experiences for Teachers (RET) program on rural mathematics, science, and technology education teachers. The STEM teachers engaged in a 6-week professional development experience focused on research and implementing the engineering design process. It demonstrated that an engineering-based RET program can increase rural teachers' commitment and readiness to incorporate the engineering design process into their regular classroom practices.

Rural Educational Leader Perceptions of Online Learning for Students with and Without Disabilities Before and During the COVID-19 Pandemic

The pandemic caused many challenges to the delivery of instruction for students. Todd Sundeen and Michelle Kalos (2022) describe the qualitative results of an online study of educational leaders' perceptions on the use of online instructional technologies before and during the COVID-19 pandemic. The article provides a unique portrait of that crucial moment for educators, students, and parents.

Building a Virtual STEM Professional Learning Network for Rural Teachers

The engagement of teachers in virtual and hybrid STEM professional learning opportunities is the subject of the article by Julie Thiele and Ollie Bogdon's (2022). The engagement of teachers resulted in three major themes of 1) increased collaborations, 2) equitable design of a professional development model that was successful at initiating a network for rural teachers to engage in STEM learning through investigations, collaborations within and between districts, and coaching activities access to resources and learning, and 3) increased content and pedagogical content knowledge. The project led to the design of a professional development model that was successful at initiating a network for rural teachers.

Virtual Summer Institutes as a Method of Rural Science Teacher Development

In this article, the team of Stephen L. Thompson, Rachelle Curcio, Amber Adgerson, Kristin E. Harbour, Legth Kate D'Amico, Hall S. Wes, George J. Roy, Melissa A. Baker, Jessie Guest, and Catherine Compton-Lilly from the University of South Carolina (Thompson et al., 2022) describe a virtual science summer institute they created as an initial component of an 18-month rural Teacher Residency program. The institute brought teacher candidates together with school-based teacher educators, university-based teacher educators, program faculty, and elementary students from the local community to take part in shared virtual teaching and learning experiences. The shared experiences occurred within authentic rural schooling contexts, provided teacher candidates with initial practice teaching opportunities, promoted the development of coaching and mentoring relationships, and allowed all stakeholders to develop common lexicon and ways of thinking about teaching.

Rural Teacher Attitudes and Engagement with Computing and Technology

The final article in this special issue on STEM teaching and learning in rural communities speaks to rural teacher attitudes toward, approaches to, and engagement with making and computational thinking during STEM professional development and co-teaching learning experiences. Melissa Mendenhall, Colby Tofel-Grehl, and David Feldon (2022) used a sequential case study-mixed method to explore and examined the ways in which teacher attitude shifted throughout professional learning and instructional practice. Three broad themes emerged in the project: anxiety, independent learner, and integration. The authors found that attitudes toward technology can be moderated.

Practice Forum

Making STEM Teaching and Learning Relevant in Rural Schools

STEMulating Interest with a Rural Place-Conscious Curriculum

In this first article, Elaine Westbrook (2022) focused on place-conscious designs that explored the increase in students' interests in STEM in grades 3-5. In this study, the effects of three informal instructional methods (hands-on, role model, and culminating projects) in a place-conscious curriculum on STEM interest were investigated. Results indicate that STEM interest increased through collaborative work, new knowledge, and action research.

All Kinds of Text: Investigating a Phenomenon Through Multimodal Media

Making STEM teaching relevant in practice is the focus of this article in the STEM teaching and learning in this rural communities special issue. As education candidates explore a real-world phenomenon through a multimodal text using the Next Generation Science Standards (NGSS) Science and Engineering Practices in order to obtain and evaluate information, candidates use the science and engineering practice of obtaining, evaluating, and communicating information to interact with a variety of information sources to help students investigate and make sense of a phenomenon of a growing, flowering, but non-fruiting tomatillo. Frederick Peinado Nelson (2022) discusses the approach of using multimodal texts that situates the learner as an investigator rather than in the traditional assignment mode.

A University-Community Partnership Model to Support Rural STEM Teaching and Student Engagement

Kathleen Kavanagh, Jan DeWaters, Seema Rivera, Melissa Carole Richards, Michael Ramsdell, and Ben Galluzzo (2022) describe a partnership between a small, private STEM university and rural schools in upstate New York which could be a model for other rural-focused universities as they strive to enhance STEM teaching and learning. University and community stakeholders were actively engaged in STEM enrichment and professional development through summer camps, after-school activities, student mentors, and curriculum designed to prepare teachers to work in high-need school districts.

Final Thoughts

We hope you enjoy this special issue of *Theory and Practice in Rural Education*. Of upmost importance to us is STEM teaching and learning in rural communities. As Azano et al. (2020) expressed:

We invite teachers to engage in the important work of remembering what is strong about rural communities, restoring that which benefits rural people and place, conserving qualities of rural communities that should be protected, changing that which oppresses or divides us, and creating innovative ways to help rural communities thrive. (p. xi)

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