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Expanding STEM Learning Opportunities in Rural Schools

Year-long professional development model champions success

Introduction

There are nine million students attending rural schools in the U.S.—nearly 20 percent of the total K-12 population. These students often have fewer opportunities for high-quality science, technology, engineering and mathematics (STEM) learning than their peers in urban and suburban schools. The Tennessee STEM Innovation Network (TSIN), managed by Battelle, champions the growth and quality of STEM education throughout the state. Focused on the kindergarten-to-jobs education pipeline, the network is developing high-quality STEM programming to ensure that rural Tennessee students are prepared for success in postsecondary and career pathways.

TSIN champions *STEM for All* students through deliberate and thoughtful STEM advocacy as well as professional development models in partnership with the Tennessee Department of Education that:

- Connect innovative schools, teachers, and administrators to one another and to state and national resources.
- Support schools and communities that want to create innovative schools and programs.
- Build community awareness and drive local school to industry partnerships.

This paper focuses on one of TSIN's initiatives: the Tennessee Rural STEM Collaborative (TRSC), an annual year-long professional development program for educators from across Tennessee that works towards ensuring that all rural students have access to high-quality learning opportunities in STEM by exposing them to 21st Century Skills and local STEM career pathways.

> We are encouraged by the tremendous commitment to STEM education across the state seen in our district and school programs, initiatives and partnerships, like with TSIN and the Tennessee Rural STEM Collaborative. This professional development program exposes Tennessee's rural educators to 21st century skills and regional career pathways they can translate directly into classroom instruction."
>
> **DR. PENNY SCHWINN**
> Tennessee's Education Commissioner

Overview Of the Rural STEM Collaborative

The TRSC is designed to::

- **Deepen** knowledge in STEM educational issues and exercise educator voice and perspective to bring positive change within their community.
- **Identify** assets within the community that can support high quality STEM education and work-based learning.
- **Expand** the sphere of influence within their school, district, and region.
- **Develop** targeted solutions that build upon assets and address current challenges within their community.

This successful initiative has now been incorporated as the model for a National Science Foundation (NSF) pilot program within HR 210 Rural STEM Education and Research Act, which is moving through the legislative process in the U.S. Congress. The passage of this bill into law will coordinate federal research and development efforts for STEM education and workforce development in rural areas, including investment in key technologies that support and improve rural STEM education.

This program is centered on the power of place, helping rural educators create dynamic learning experiences that develop pride and deeper understanding of the rural communities across Tennessee. Cohort members interact in professional learning communities that concentrate on a specific area of focus: **Community & Postsecondary Partnerships, STEM Integrated Curriculum & Instruction, and Family Engagement**. For each area of focus, participants engage in targeted professional development and meet experts in the field.

The TRSC is open to K-12 Tennessee public school teachers of any subject interested in learning more about STEM educational issues and developing solutions to those issues specific to their students and communities.

[1] Retrieved from https://www.congress.gov/bill/117th-congress/house-bill/210

The Power of Place-Based Education

The TRSC program design uses Place-Based Education as a catalyst to help revitalize rural communities by engaging students and teachers in solving community challenges through a STEM lens. The projects increase student and teacher engagement and positive student outcomes. Teachers integrate innovative instructional approaches that support student agency, boost access and opportunity, prioritize deeper learning, and personalize learning experiences while building the capacity of rural educators and students across the state.

Experts on place-based education believe that extended community-connected challenges are the best way to build important skills, such as agency, collaboration, and an entrepreneurial mindset.[2] New educational models incorporate a new appreciation for the learning sciences, and high-engagement learning experiences are designed to include better ways to provoke and measure learning. "Place-based education sits firmly in the center of next-generation learning models and is a key to learner-centered school transformation," state the authors of The Power of Place: Authentic Learning Through Place-Based Education, the book used by TRSC teacher participants as the foundational text.

Cohort members begin by identifying STEM education needs and gaps in their local communities and they then design an intervention that is personalized to meet that rural need.

Teachers need to see the opportunity and potential of their local spaces, partners, and cultures. Focusing on place-based education helps them make those connections.

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The six design principles of place-based education include:

The TRSC is designed to::

- **Community as Classroom:** Communities serve as ecosystems for schools where local and regional experts, experiences, and places are part of the expanded definition of classroom.
- **Learner Centered:** Learning is personally relevant to students and enables student agency.
- **Inquiry-Based:** Learning is grounded in observing, asking relevant questions, making predictions, and collecting data to understand the economic, ecological, and sociopolitical world.
- **Local to Global:** Local learning serves as a model for understanding global challenges, opportunities and connections.
- **Design-Thinking:** Design thinking provides a systemic approach for students to make a meaningful impact in communities through the curriculum.
- **Interdisciplinary:** The curriculum matches the real world, with the traditional subject area content, skills, and dispositions taught through an integrated, interdisciplinary, and frequently project-based, approach in which all learners are accountable and challenged. [3]

[2] Retrieved from https://www.gettingsmart.com/powerofplace/
[3] Ibid.

Defining Rural STEM Needs

All projects incorporate one or more of the place-based learning principles listed above and integrate essential questions that explore science, technology, math, and engineering disciplines. Teachers enter the program with different levels of STEM knowledge. Over the last year, teachers created a wide range of projects with purpose statements, such as the following:

I want to integrate hands-on water education learning since most of our science curriculum is reading based. I also want to explore place-based learning with my students because my school has underutilized grounds that contain streams, a pumpkin patch, and a corn maze.
I had no idea what STEM really does inside the classroom, so I want to learn more about it, so I can start incorporating it within my classes daily.
Develop a "Growth Mindset" block of curriculum and instruction that could be used by mathematics teachers during the first week of each semester to debunk the "Fixed Mindset" in math so that students shift from "I cannot do math," to "I think I can, and I am willing to try."
STEM is obsolete in our elementary school. The goal is to introduce STEM learning to our teachers, staff, students, and our families. We will do that through our Family STEM night.
The need is a little different for us. We have the resources throughout the building, and they aren't being utilized. Our project is to get teachers and staff to integrate STEM into their lessons.
To expose students to their ancestors and connections to Oliver Springs with the use of storytelling, interviews, Ancestors.com, WeVideo, and communication skills to explore what it was like to live in small towns throughout history.
We are a Title I school. Our county has a high unemployment rate. I wanted to address unique STEM activities that our students do not have access to in our school. We were able to buy a drone and a circuit rover through this program as well as apply $100 toward supplies to have a STEM night at our school.

Teachers need to see the opportunity and potential of their local spaces, partners, and cultures. Focusing on place-based education helps them make those connections.

Case Studies: STEM Educator Profiles

Three cohorts of teachers work together in East, Middle, and West Tennessee throughout the school year within a structured program of support and accountability grounded in Place-Based Education principles. Elementary, middle, and high school teachers, counselors, and library media specialists design a variety of STEM initiatives in their local communities. The four educator profiles below provide a snapshot of their STEM initiatives and the impact on their students and communities.

Creek Wood High School, Dickson County

Yvonne Schlangen (10-12th grade science teacher & special population interventionist) wanted to collaborate with colleagues to create a health and wellness survey that would become a resource for the community. Her students designed a website to raise awareness for health and wellness. Students then developed a survey and online tool that helps community members determine where to begin their health journey: diet, exercise, or mental health.

Her students, many of whom were special education students, created a student-led project that surpassed all of Schlangen's expectations. "These students wanted to help their community focus on living longer, healthy lives," said Schlangen. "When a student has the right supports in place, they have the same chance to succeed as their peers, and that is making sure that every student has an equal chance to grow and develop."

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> **YVONNE SCHLANGEN**
> *10-12th grade science teacher & special population interventionist*

Rush Strong School, Jefferson County

Susan Martin (7-8th grade science teacher) aimed to provide added enrichment to her 7th grade classes. She partnered with the education program at Carson-Newman University to bring pre-service teachers into her classroom once a week to facilitate STEM activities. Pre-service teachers collaborated with Martin twice per week to design and implement an authentically engaging project/problem-based learning (PBL) lesson focused on cellular respiration.

Martin wanted to promote high-level STEM learning with her students as well as help the Carson-Newman pre-service teachers build a foundation in PBL. This gave the pre-service educators a stronger understanding of high-quality learning in action before entering the classroom and gave her students an opportunity to explore a science topic more deeply.

"Strawberry Plains is incredibly small with few businesses to partner with. The TRSC program encouraged us to branch out and shared an example of how larger universities partner with surrounding counties and teacher preparation programs. Carson-Newman University was excited to see how this project could enhance their teacher prep program."

Lakeland Preparatory School, Shelby County

Quanta Hess (6th grade STEM and science teacher) chose to partner with several police departments and agencies in her community. Hess introduced her students to forensic science in a real-world setting, which led to the development of CSI Crime Scene Story videos by each student. The students researched the salary, certification, schools, and training of forensic scientists and spoke to local experts.

The project's goal was to have students design and reconstruct their own individual crime science investigations and demonstrate how to collect, preserve, and analyze forensic evidence. The 6th graders then wrote scripts and cast themselves in their own crime story and even processed their own latent fingerprints. Community law enforcement agents were available to students to answer questions relevant to students' goals and to create personal relationships with officers.

"Everyone wanted a piece of the action and were thrilled to help support our students in their reconstructed crime scene efforts: Mom, Dad, siblings, and even family pets were cast in videos," said Hess. "I felt proud watching my students engage in action learning and apply STEM disciplines that were fun, challenging, and applicable to the real world."

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> *6th grade STEM and science teacher*

Jack Anderson Elementary, Sumner County

Ashley Warnement (kindergarten teacher) sought to create a space where kindergarten and first grade students could become engaged within their school community. The project grew into a community effort that involved community partners, other teachers, parents, and students as they developed a student-designed sensory walk. Students watched videos of sensory walks and then designed their own that incorporated how they wanted to move their bodies while outside.

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The project attracted other teachers, family members, and community partners. Now they plan not just to sustain the walk moving forward but expand on it. They have added a stage where students can sing and dance. Warnement wants to paint a mural, incorporate additional games, and perhaps add a chicken coop.

"I have several kids in my classroom with autism and watching them not just play next to but actually physically interact with their friends has confirmed that this is what we want to do," said Warnement. "This project really made these kindergartners more empathetic. When we explained why the sensory walk was important, they really keyed in on their friends that maybe needed that extra hand, or that extra buddy."

Stakeholders Survey Results

A June 2020 survey of participating students, families, and community partners recorded nearly universal support for the program. Community partners primarily worked with either middle/high schools (60%) or elementary schools (40%). Almost all partners (98-100%) strongly agreed or agreed that the experience was fulfilling, meaningful, and a good use of their time. These results have been consistent since evaluation began during the 2018-2019 implementation year. [4]

Ninety-six percent of parents and families who participated in the STEM events agreed that they developed a much better understanding of STEM and felt that it was important and meaningful for students to participate. Ninety-two percent also reported that they better appreciate the work that teachers do.

After students engaged in their teacher's TRSC project, 95 percent of students reported they now consider STEM important. Examples of students' responses include:

Category	Response	Examples
Personal/ Career Skills	**58%**	*"STEM is important for jobs later in life;" "STEM is important because it can challenge us to work harder."*
Personal Enjoyment	**19%**	*"STEM is the coolest thing I have ever experienced;" "It's a fun way of learning."*
Cultural/ Technological Contributions	**14%**	*"You can help out your community with STEM projects;" "It's important because it's always part of our lives."*
Academic Achievement	**12%**	*"STEM really helps with education;" "STEM provides an extra level of learning that is typically not taught in school."*

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[4] The Center for Research in Educational Policy at the University of Memphis worked as the external evaluator for the TRSC program conducting formative and summative programmatic assessments.

Teacher Perspectives of the Experience

Cohort members were enthusiastic and grateful for the experience, including the networking with other rural educators and community partners across the state. In addition to completing their year-long projects, almost 25 percent of the teachers reapply to TRSC for funding to expand their initial projects. Here is what teachers had to say about their experience in the TRSC program.

"It was really cool to connect with teachers from around the state and to see what everyone else is doing for STEM because you kind of get into your own little world and you think, "Oh, we're doing these great things." Then you realize you are doing great things, but there are other really great things that you could do, so it was nice to pull ideas from other people."

"I never thought of chemistry as the "S" in STEM. Participating in this collaborative really opened my eyes to think outside the box. I feel more confident in finding resources (including partners) for learning and how to think of all aspects of what I'm doing in the classroom in terms of STEM. I really want to develop more PBL experiences for my students."

"Without this group, the robotics tournament would still be just an idea. With your help, I was able to make it happen and with continued community support we will continue it each year."

"This has been a great opportunity to connect with other rural STEM teachers."

"This program has helped me grow as a STEM teacher and my students as STEM learners."

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TRSC Learning Model Codified in Federal Legislation

HR 210, the Rural STEM Education Research Act addresses inequities for rural students that make it harder to participate in quality STEM education. It gives teachers more STEM resources and training; engages students in hands-on STEM learning within their communities; increases access to broadband and supports research to improve the quality of STEM learning in rural communities. [5]

The need is clear. "80 percent of the fastest growing occupations depend upon mastery of STEM skills and the number of STEM jobs is growing three times faster than non-STEM jobs. To succeed in this job market, our students need to be equipped with solid skills in science and engineering. Meeting this demand starts in the classroom," said Frank Lucas (OK-3), the bill's sponsor.

The fact that the TRSC model is being recognized in a major piece of legislation as a system of strategies that shifts the mindsets of rural educators and communities to show them the power of STEM education is notable to Brandi Stroecker, Director of TSIN.

"To succeed in this job market, our students need to be equipped with solid skills in science and engineering. Meeting this demand starts in the classroom."

FRANK LUCAS
(R) Oklahoma's 3rd congressional district

"TSIN is a member of the STEMx Network, managed by Battelle, that briefed the STEM Education Coalition in Washington, D.C. and informed the bill's development by the House Committee on Science, Space and Technology. The impact and metrics of success that we are seeing with the program has directly shifted the narrative around priority projects for the National Science Foundation and other organizations to fund. That's the importance for us as a network; we are agents of change."

[5] Retrieved from https://lucas.house.gov/news/press-releases/lucas-rural-stem-education-bill-passed-house

About the Tennessee STEM Innovation Network

The Tennessee STEM Innovation Network (TSIN) supports the growth and quality of STEM education in Tennessee. TSIN is a partnership between the Tennessee Department of Education and Battelle that develops high-quality STEM programming to ensure that Tennessee students are prepared for success in college and career and ready for the future of their choosing.

About the Center for Research in Educational Policy

The Center for Research in Educational Policy (CREP) is part of the College of Education at the University of Memphis and is designated as a State of Tennessee Center of Excellence. For 30 years, CREP's primary mission has been to conduct rigorous research and evaluation in K-12 schools and higher education as well as community outreach programs.

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