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Sustainable STEAM Implementation in a Small Rural High Poverty School District

Ginny Cartee and Cindy Wright
Laurens County School District 55, Laurens, South Carolina, USA

ABSTRACT

STEAM implementation in public schools is essential for economic development of communities and college and career readiness of high school graduates. Practical knowledge is limited on ways this can be accomplished in high poverty rural K-12 school districts. This article introduces a STEAM implementation framework based on guidance from a Math-Science Partnership grant project. The purpose of the article is to present key characteristics of STEAM education implementation, recognizing innovative curriculum designs and pedagogical strategies for utilization by schools with limited financial and community-based resources. The framework provides practical suggestions for planning and implementing STEM education in rural schools.

Keywords: High poverty, rural, sustainable STEAM, school system, math program, science program, technology

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INTRODUCTION

This narrative will describe the process used to build a foundation for sustainable STEAM implementation in high-poverty rural school districts. STEAM implementation in public schools is essential for the economic development of communities and college and career readiness of high school graduates. The district discussed in this article utilized the guidance and requirements of a

National Science Foundation Math and Science Partnership (MSP) Grant Project (National Science Foundation, 2010) and technical support from the State Department of Education to design a district-wide project aimed at improving student achievement in math and science. The funding opportunity requirements for needs assessment, data-informed decision making, community partnerships, and collaboration, as well as anecdotal information from stakeholders, were used to define instructional characteristics and student achievement baselines. A review of best practice strategies was conducted. The project development team organized strategies and activities for STEM implementation beginning by filling gaps in teacher knowledge of STEM instruction focused on matching local resources with the needs identified by the MSP grant management team.

LITERATURE REVIEW

After over a decade if implementation, the current research supports the key findings of the MSP project including the need for institutional change within school districts, collaboration with higher education, coordination with community stakeholders, increased number of teachers with deep understanding of STEAM and improved instructional quality and capacity related to applied math, science and innovation in all grades. *STEM/STEAM Policy Trends* findings indicate STEAM approaches allow for enhanced problem- or project-based learning and student inquiry and experimentation. (Education Commission of the States, 2024). *Findings published in Procedia Computer Science* emphasize the need for both convergent and divergent problem solving to position graduates for global competitiveness within the STEM job market. (Land, 2013). The *Journal of STEM Arts, Crafts, and Constructions,* provides additional evidence for the value of STEAM instructional strategies in an overview of the arts and STEM integration. The editorial outlines an analysis of the benefits of arts integration with STEM subjects, and an overview of the history of the arts anchor standards. (Ksenia Zhbanova, 2017)

DISCUSSION

The Local Implementation Process

The district grant planning team met to review the goals and objectives of the MSP project. Requirements were used to identify gaps in district practices compared with best practice. Local goals related to increasing teacher quality, student achievement and local employability of graduates were refined to develop a plan leveraging local resources and potential grant funding requirements as the first step in implementing STEAM (Science, Technology, Engineering, Arts and Math) in all schools within a small high poverty rural public school district. To

ensure motivation for educator participation, the initial project plan proposed professional development in a wide variety of formats, including graduate courses as well as recertification opportunities such as after-school workshops, Saturday Cohorts, and Summer Institutes. The project team utilized this preliminary information while searching for potential funding sources and discovered the National Science Foundation's Math and Science Partnership Opportunity. An outside evaluator was selected to assist with project design and the district grant writer was added to the planning team.

Need Assessment: Defining Baseline Teaching and Learning

With the guidance of the evaluator a comprehensive needs assessment of STEM instruction was completed. The team investigated student achievement, instructional practices and teacher input. Results of the initial evaluation found that elementary students with on-target test scores often scored well below standard in middle school. At the high school level fewer than expected students chose technology courses including advanced science, math and Project Lead the Way (PLtW) engineering classes. The project team also reviewed instructional strategies, use of instructional materials, course standards, curriculum implementation and teacher efficacy. Teacher focus group responses and instructional artifacts from math and science classrooms were collected and analyzed.

STEM Needs Assessment Findings

Findings of the initial assessment included evidence of teachers using "tricks of the trade" to improve test scores. Memorization of isolated facts believed to be common on state tests and a focus on computation were emphasized over understanding and application of concepts. Comprehension of complex information was avoided. Investigators found teachers could recite formal problem-solving processes, but did not feel confident in using or teaching problem solving as a process. Teachers agreed the lack of STEM instructional materials was a major barrier for hands-on and project-based learning. Additionally, many teachers did not believe their knowledge of current STEM content was sufficient and knowledge of connections among instructional content, college/career readiness and real-world innovation was also lacking. Instructional staff and school administrators stated many professional development activities did not meet the needs of educators and most opportunities did not allow time for discussion and reflection. The project team decided to address these findings by developing a plan to enhance the understanding of STEM processes and the applications of academic content, with a focus on seamless progression through all grades and an emphasis on college and career readiness.

Including the Arts

At the same time the planning team was meeting, the Department of Education was developing new arts standards and exploring arts connections with other academic content (Hockman, 2014). The district interim arts coordinator was added to the team to assist in describing connections among the arts, STEM and innovation. The availability of state funded arts integration professional development and the framework for state funded Summer Arts Teacher Institutes provided a model for including the Arts in the STEM project.

The Initial Summer STEAM Institute

To energize teachers as agents of change, both content area and arts teachers were invited to participate in a two-week summer STEAM Institute. A Jigsaw approach was used to maximize the exchange of ideas among participants (University of Maryland, 2025). Vertical teams were created with members from each grade band (elementary, middle and high school) and an arts teacher was assigned to each team. Arts teachers facilitated discussion of authentic evaluation of soft skills, creativity and innovative exploration of instructional materials. Science and math teachers facilitated approaches to problem-solving and presented grade band curriculum summaries to scaffold understanding of STEM concepts. Content area teams and grade band teams met each day during the institute for discussion and reflection. Vertical teams presented capstone projects. Teams shared digital resources at the end of the institute. School administrators attended the institute to ensure top-down support for teachers willing to apply STEAM strategies in classrooms. Participation of the grant writer and evaluators simplified project evaluation and the search for resources including funding for STEAM instructional materials.

Community partners provided field experiences including visits to a genetics research center, water quality investigations designed by a local university and real-world STEM innovative applications staffed by local corporate scientists serving as facilitators. Local business and higher education support came from the County Chamber of Commerce, Technical College Center for Advanced Manufacturing and automotive innovation experiences were provided by Michelin, BMW and Z-F Transmissions. All field experiences confirmed connections among k-12 STEAM, college/career readiness and real-world careers.

Including the grant writer and evaluators encouraged using precise language to define steps in the process, specific project goals and objectives, desired outcomes and impacts. This understanding created the opportunity to create an efficient synergistic approach to introducing STEAM across the district beginning with rigorous professional development. Summaries from participant discussions and reflections were used to plan follow-up professional development

activities to meet the needs of teachers and scaffold STEAM best practice instruction.

CONCLUSIONS

The project impacts include increased participation of community stakeholders, changes in professional development and a shift from being driven by state achievement test scores to being informed by continuous assessment of both teaching and learning. The addition of Arts has also improved educator commination within professional learning groups and increased positive community engagement through school and district STEAM events.

Partnerships with local colleges, business, industry and community organizations have provided resources for schools and students. For over a decade partner have provided internships, field experiences and scholarship opportunities for district students. Higher education partners have provided scaffolding through STEM content graduate courses for teachers as well as workshops and cohort experiences for recertification credit. The district has continued utilizing professional development provided by the state to train instructional coaches, Arts teachers and PLtW instructors.

Data has become a tool focused on continuous improvement. Teachers and administrators take time to analyze and use data to inform academic interventions for students and coaching opportunities for individual teachers. Professional Learning Groups from each school and across the district provide time for refection and communication within vertical content teams.

The project has supported enduring changes in arts instruction. Arts teachers have adopted descriptions of arts strategies related to the *SC Graduate Profile Competency Framework* and *Habits of the Mind*. The following charts list Arts Descriptions used to guide district arts instruction, ensuring that all arts classrooms focus on the development of essential STEAM soft skills.

The impact of innovative STEAM is evident in every content area. Implementation has encouraged collaborative classroom instruction and grant funding has made it possible to provide instructional materials to extend the use of strategies included in basic engineering courses.

The exploration of *Habits of the Mind* has encouraged teachers to include innovative strategies as students apply math and engineering principles to program robots and address real world problems. Classroom examples include students improvising music theory using digital piano labs and elementary music students using homemade instruments to create music by manipulating sounds, a State Champion High School Robotics team and kindergarten students programming robotic cars to explore a miniature city designed by classmates. At the middle school level, a visual arts class was challenged to research design structures to withstand a specific natural disaster and to build models from original designs. Working with science teachers and a local architect, students created blueprints, then built structures based on their drawings.

Table 1
Arts Strategies Supporting the South Carolina Graduate Profile Competency Framework. (South Carolina Department of Education [SCDE], 2021)

Skills	Arts Description
1. Creativity & Innovation	Creating art and music requires creative applications of current knowledge. Presentation requires innovative interpretation and analysis of themes and media used in production of artworks.
2. Critical thinking & problem solving	Creation, presentation and evaluation of work require artistic problem solving and critical thinking.
3. Collaboration and teamwork	Small group arts work requires collaboration to create and present work. Reflection on meaning & representation are required to evaluate work.
4. Communication, information, media & technology	The use of technology for creating and presenting art works and music in digital form requires focus on the art and mastery of the technology as a tool.
5. Knowing how to learn	Applying knowledge from direct instruction to create or improvise artworks and music is required to create pathways to new learning.
Characteristic List	
1. Integrity	Best effort, accepting evaluations and development of presentations improve chances for success in the arts and in life. Integrity is required for honest self-evaluation of work and when evaluating the work of others.
2. Self-direction	The ability to focus and maintain attention on theme and technique are required in creative problems solving.
3. Global Perspective	Creating original art works and music using representations from many cultures and art forms requires understanding the perspectives of artists and performers from other cultures.
4. Perseverance	Perseverance is required to create and then revisit work to revise, edit and present visual artworks and music.

5. Work Ethic	Practice, revision of work, preparation for sharing work & development of presentations require consistent effort. Organization of shared spaces within classrooms requires constant attention to maintaining an efficient classroom and orderly environment that works for everyone.
6. Interpersonal Skills	Small group work to respectfully create, evaluate and reflect on meaning and presentation of works in a performance, physical gallery or digital format requires the ability to communicate with and understand others.

Table 2
Habits of the Mind and Arts Strategies Supporting STEAM Implementation

South Carolina Department of Education Arts Resource Page (May 2025)
Habits of Mind – Approaches to learning that focus on traits, thought and process exemplified in learning practices such as those set forth in the engineering process and the mathematical practices. Studio habits of mind include Observe, Reflect, Envision, Stretch and Explore, Express, Develop Craft, Understand Community, Engage and Persist.
Studio Habits of Mind (Winner, 2006)
Develop Craft: Learning to use tools, materials, artistic conventions; and learning to care for tools, materials, and space.
Engage and Persist: Learning to embrace problems of relevance within the art world and/or of personal importance, to develop focus conducive to working and persevering at tasks.
Envision: Learning to picture mentally what cannot be directly observed and imagine possible next steps in making a piece.
Express: Learning to create works that convey an idea, a feeling, or a personal meaning.
Observe: Learning to attend to visual or sound contexts more closely than ordinary "looking" or "listening" require, and thereby learning to see and to hear things that otherwise might not be noticed or understood.
Reflect: Learning to think and talk with others about an aspect of one's work or working process, and, learning to judge one's own work and working process and the work of others.
Stretch and Explore: Learning to reach beyond one's capacities, to explore playfully without a preconceived plan, and to embrace the opportunity to learn from mistakes.

Understand Arts Community: Learning to interact as an artist with other artists in classrooms, local arts organizations, across the art field and within the broader society.
STEAM Competence FOUNDATION requires:
Basic Skills - including reading, writing, arithmetic and mathematics, speaking and listening
Thinking Skills - thinking creatively, making decisions, solving problems, seeing things in the mind's eye, knowing how to learn, and reasoning
Personal Qualities - individual responsibility, self-esteem, sociability, self-management and integrity.

The intentional implementation of sustainable STEAM strategies has made it possible for the district to leverage funding and partnerships to provide world class opportunities for students in this small high-poverty rural district. The STEAM initiative has created individual and group recognition, scholarships, internships and the opportunity for the district to work with stakeholders in hosting countywide events to share the STEAM vision of the district and the 21st Century accomplishments of students.

IMPLICATIONS

The project demonstrates benefits of the implementation of a STEAM framework to create and implement a STEAM-friendly instructional culture in districts with limited resources. By developing partnership-driven work uniting k-12 and higher education with representatives from local business and industry, districts can improve teacher quality and increase the quantity of STEAM teachers. By creating professional development opportunities that meet the needs of teachers and provide long-term, coherent strategies to address teacher efficacy and quality, teacher satisfaction and student achievement improve. By focusing on evidence-based strategies and providing opportunities to acquire and apply knowledge coupled with instructional materials needed to address gaps in classroom resources, any district can use STEAM strategies to make high school graduates college and career ready.

Experiences over the past decade suggest the essential role of instructional leadership in all classrooms. By teaching teachers to use *Habit of Mind* thinking and focus on developing the skills and characteristics needed for college and career readiness, lead teachers and instructional coaches can address gaps in teacher knowledge and efficacy related to STEAM instruction. Providing assistance with data analysis related to both teaching and learning encourages teachers to think of achievement scores as a starting place for continuous improvement. Allowing time for professional learning groups to reflect on and discuss a vertical vision of K-12 curriculum encourages seamless progression of students through the grades. By

including arts teachers, content area teachers learn alternative and authentic assessment strategies to measure student understanding to bolster student academic achievement.

The project also points to the changes needed in teacher preparation and recertification programs, potential community college coursework and educational leadership practices. Constant changes in real-world STEAM applications require all teachers to acquire sufficient content knowledge to think beyond the basics in both science and mathematics. Educators need practice in using data to inform rather than drive instruction. Teachers need to be familiar with engineering processes, creative and divergent problem-solving and STEM career opportunities. Greater collaboration with colleges and universities in the development and delivery of STEAM coursework for k-12 teachers could create instructional innovators able to leverage community strengths to fill gaps in instructional resources and make the STEAM vision a reality for all students in every public school district.

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GINNY CARTEE, MED, is a retired STEM teacher, current district grant writer and current special projects coordinator for Laurens County School District 55, Laurens South Carolina. Her major interests include writing and coordinating grant projects to support STEM Education, After School Programs, Arts Education, and Community Projects focused on Public Health, Economic Development and Outdoor Built Environments. Email: gcartee@laurens55.org

CINDY WRIGHT is a Visual Arts Teacher and the District Visual and Performing Arts Coordinator for Laurens County School District 55, Laurens South Carolina. Her major interests include coordinating school and district arts grant projects and facilitating connections with artists and other stakeholders within the community. Email: cpwright@laurens55.org

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