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Partnering with Local Industries to Drive STEM Engagement: A Solar Energy Case Study in West Virginia

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ABSTRACT

This paper explores the integration of local industry partnerships to enhance STEM education in rural middle schools through renewable energy education. By collaborating with a regional solar grid and battery storage company, students engaged in hands-on lessons using Snap Circuits® kits to explore electricity, solar power, and energy grid design. Students designed and connected solar-powered model homes to simulate a solar grid network. These activities fostered critical thinking, systems thinking, and collaborative problem-solving, making STEM careers tangible and accessible. This study highlights the importance of leveraging local industries to create authentic, place-based STEM experiences that foster career awareness, deepen understanding, and enhance student engagement.

Keywords: Place-based learning, renewable energy, project-based STEM, rural education, career connections

INTRODUCTION

Incorporating partnerships with local industries into STEM education presents transformative opportunities to enhance student engagement, contextualize learning, and foster real-world career connections. In rural areas, where students often have limited exposure to STEM career pathways, making education locally relevant is critical. This paper describes a solar energy education project conducted in partnership with a West Virginia-based solar grid and battery company. Through hands-on learning with Snap Circuits® Green Energy kits and guided design challenges, students learned fundamental energy concepts and built solar-powered models. They explored the structure and importance of modern energy grids. Integrating place-based learning with renewable energy topics provides a model for enhancing STEM instruction and preparing students for 21st-century opportunities.

LITERATURE REVIEW

Place-Based Learning in STEM Education

In rural areas, like West Virginia, where students often have limited exposure to STEM careers, Place-based learning (PBL) has recently emerged as a significant educational strategy in STEM curricula. By anchoring learning experiences in local, real-world career options, PBL enhances student engagement and puts abstract STEM concepts into a practical context. Azano et al. (2020) emphasize that PBL activities connect core classroom content to the real world and local environments, making learning more relatable and tangible. In rural areas, leveraging community industries and natural resources not only helps students envision future careers but also strengthens the local workforce pipeline. Recent studies have highlighted the effectiveness of integrated STEM curricula that incorporate local knowledge and community practices. For instance, Knowles et al. (2023) discuss the TRAILS 2.0 project, which addresses the educational needs of underserved rural students by implementing an integrated STEM curriculum that utilizes local ecosystems and industries to create relevant learning experiences. The National Academies of Sciences, Engineering, and Medicine (2024) report emphasizes that rural areas present unique opportunities for STEM education, offering access to natural spaces and community-based resources. These findings suggest that PBL not only enhances academic outcomes but also fosters a sense of stewardship and responsibility toward the local community, which is crucial for sustained engagement in STEM fields.

Renewable Energy and STEM Engagement

Integrating renewable energy topics into STEM education has been shown to deepen students' understanding of complex systems and inspire interest in environmental sustainability and energy careers. Kricorian et al. (2020) found that hands-on exploration of renewable energy technologies, such as solar panels and battery storage, encourages interdisciplinary learning by integrating principles from physics, engineering, environmental science, and technology. This approach demystifies emerging industries and motivates students to consider and pursue careers that address global challenges, such as climate change. Recent initiatives have demonstrated the impact of renewable energy education on student engagement. For example, the Energizing Student Potential Program engaged over

80,000 students across 322 schools in hands-on activities related to energy science and renewable technologies, fostering practical skills and awareness of energy careers (National Energy Education Development Project, 2024). Additionally, Uddin and Sultana (2024) reported that sponsored summer camps focusing on renewable energy education significantly increased the interest of middle and high school students in STEM fields and environmental issues. These programs highlight the potential of renewable energy education to align with national education priorities and prepare students for careers in green technologies and sustainable development (National Energy Education Development Project, 2024).

Hands-On Circuitry and Student Learning

Hands-on learning experiences involving circuitry have been shown to help students conceptualize electrical systems and energy transfer. Zhan et al. (2021) demonstrated that using manipulatives, such as Snap Circuits®, significantly improves students' understanding of electrical circuits by providing tactile and visual learning opportunities. These types of experiences strengthen critical thinking and collaborative skills, making abstract concepts more accessible. Fior, Fonda, and Canessa (2024) further support this by illustrating how integrating digital technologies in hands-on STEM learning fosters collaboration, creativity, and problem-solving skills among students. Programs like STEM Sparks allow students to design circuits and understand current flow, directly connecting theoretical knowledge with real-world applications (Iowa State University Extension and Outreach, 2023). Hands-on activities like these promote systems thinking, the development of problem-solving skills, persistence, and resilience as students modify their designs and troubleshoot errors to meet given criteria. Educators can create more inclusive and effective STEM learning environments that cater to diverse learning styles and needs by engaging students in active learning. West Virginia's middle school CTE standards encourage the integration of hands-on, real-world activities that foster career exploration. The project discussed aligns closely with this emphasis.

Through the "Discover Your Future" program, students in grades 6–9 are introduced to various career opportunities across the 16 career clusters, including Science, Technology, Engineering, and Mathematics (STEM). By applying circuitry knowledge to build solar-powered models and explore energy systems, students gain practical experience that supports the development of problem-solving, critical thinking, and teamwork skills — core competencies emphasized in West Virginia's Career and Technical Education (CTE) framework. This hands-on, self-exploration enhances student understanding of green energy concepts while encouraging them to consider future careers in this industry. This aligns with the state's emphasis on preparing students for high-demand industries through experiential learning opportunities.

In addition to meeting CTE goals, the solar energy education project aligns with several West Virginia College- and Career-Readiness Standards for Science in grades 6–8. For instance, MS-PS3-3 requires students to apply scientific principles to design, construct, and test devices that convert energy from one form to another—an objective fulfilled through building and testing solar-powered Snap Circuit® models. MS-PS2-3, which involves designing solutions to problems involving the motion of objects, is supported as students test solar panel positioning and circuit design to optimize energy flow. MS-ETS1-2 and MS-ETS1-4—engineering design standards—are addressed as students define design problems, develop models, and perform iterative testing to improve their solar-powered communities. These activities also promote systems thinking, which aligns with crosscutting concepts outlined in the Next Generation Science Standards (NGSS). Additionally, students demonstrate collaboration and communication skills while presenting their models and explaining energy concepts, thereby supporting the state's technology integration standards, emphasizing authentic tasks, and solving problems using digital tools. These standards ensure the project supports academic rigor while fostering 21st-century skills.

Place-based learning is not merely a pedagogical supplement; it represents a critical shift in how STEM content can be taught with real-world relevance and a high impact on students. When instructional design lines up with students' lived experiences or addresses urgent global concerns, engagement often deepens in measurable and meaningful ways. Boz et al. (2025) demonstrated that a five-day, place-based STEM workshop centered on disease ecology significantly increased both student participation and conceptual understanding among underserved middle school learners. This outcome illustrates the power of connecting academic content to local and tangible contexts.

Similarly, the work of Ajayi et al. (2024) reveals the cognitive and affective benefits of integrating sustainability themes into high school STEM curricula. By incorporating topics such as renewable green energy into STEM instruction, educators not only enhance students' comprehension but also emphasize the critical thinking and problem-solving skills necessary for addressing the complex challenges of the 21st century. These approaches do more than convey information; they cultivate agency and intellectual curiosity.

Together, these studies reinforce the importance of designing STEM education that reflects both the immediate realities and future responsibilities of students. Grounding science and engineering in authentic, community-based, and environmentally focused frameworks supports not only academic achievement but also long-term engagement with STEM pathways. For rural and underrepresented student populations in particular, these methods offer a pathway toward equitable and purpose-driven learning.

RESEARCH METHOD

CASE STUDY: SOLAR ENERGY EDUCATION INITIATIVE

Building the Partnership

A local solar energy company specializing in grid and battery storage technology partnered with a rural middle school to support renewable energy education. The company donated Snap Circuits® Green Energy kits and provided informational sessions on the importance of solar grids in sustaining energy availability.

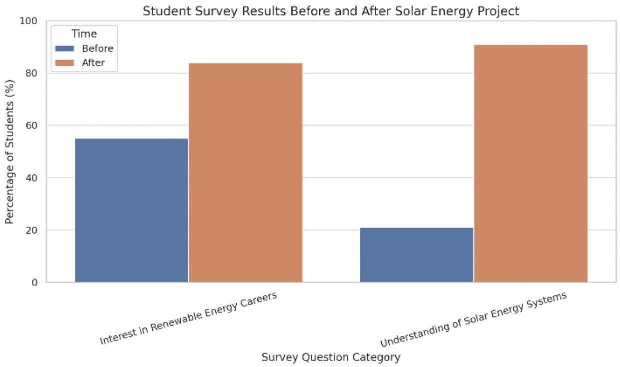
Lesson One: Exploring Basic Electricity and Solar Principles

After an introduction to electrical systems and solar energy, students worked in pairs using Snap Circuits® kits to complete quick builds involving batteries, solar panels, and basic loads (motors, lights, buzzers). Students received diagrams and worked independently, encouraging self-guided learning and collaboration. Midway through the activity, students were introduced to the concept of solar energy grids and the importance of energy storage.

Lesson Two: Designing a Solar-Powered Community

Students worked in small groups to design solar-powered model homes using Snap Circuits® Green Energy kits. Each home incorporated solar panels and basic circuits, and groups collaborated to connect their homes, modeling a miniature solar-powered grid. Students faced real-world design challenges and engaged in iterative testing and optimization.

STUDENT OUTCOMES



The program was piloted in five middle school classrooms across the state, involving approximately 120 students. The survey was conducted on Microsoft Teams and made available to students through their Learning Management System (LMS) before and after the lesson. Students answered anonymously, and the results were compiled in an Excel spreadsheet for analysis and review. Informal classroom surveys revealed that:

- 84% of students reported greater interest in renewable energy careers following

the project. (As compared to 55% before the activity)
- 91% of students felt more confident in understanding how solar energy systems work. (As compared to 21% of students before the activity),

Survey Question	Before Lesson (%)	After Lesson (%)
Interest in Renewable Energy Careers	55	84
Confidence in Understanding Solar Energy Systems	21	91

LIMITATIONS AND LESSONS

While the solar energy education project yielded positive results, several limitations should be taken into consideration. Although classrooms were distributed across West Virginia, the sample size of 120 students limits the generalizability of the findings. The study included a pre-activity survey; however, both surveys relied on self-reported data without the use of validated instruments or direct measures of learning. The short duration—two lessons—restricts conclusions about long-term impact. While the project aligned with state academic and CTE standards, no performance-based data were collected to assess mastery.

For educators looking to replicate or adapt this model: a) Start Local: Reach out to regional industries aligned with STEM fields. b) Integrate Standards: Connect project goals to national and state curriculum standards. c) Emphasize Systems; d) Thinking: Allow students to encounter real-world complexity. E) Prioritize Flexibility: Scaffold activities to accommodate various learning styles.

DISCUSSION AND CONCLUSIONS

Educators can foster engagement, deepen conceptual understanding, and promote career awareness by integrating local industry partnerships into STEM instruction. Preparing students for emerging industries in their communities strengthens both individual futures and local economies.

Future research could explore the long-term impact of industry partnerships on student interest and achievement in STEM, particularly in rural settings. Studies may include longitudinal tracking to assess sustained interest in energy careers, integrating performance-based assessments to measure content mastery, and collecting qualitative data, such as student and teacher interviews. Expanding the program to include more diverse regions and school types could also help determine how scalable and adaptable the model is across different educational contexts.

I
MPLICATIONS

Integrating local industry partnerships into STEM curriculum design carries several key implications. First, it supports the development of place-based learning experiences that make instruction more relevant by aligning content with regional workforce needs. This approach encourages project-based and performance-based assessments, allowing students to demonstrate understanding through real-world applications rather than traditional testing. It also embeds career exploration into classroom learning, promoting early awareness of STEM pathways. Educators may require targeted professional development and opportunities to co-design instructional units with industry experts to implement such curricula effectively. Additionally, curriculum models should be adaptable to different school settings to ensure equity and scalability, particularly in rural or resource-limited areas. Finally, incorporating feedback loops, such as student interviews and longitudinal data, can help refine and sustain the effectiveness of the curriculum.

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