

STEM & LEADERS

LEADERS is a mathematics and science partnership that gathers and merges the expertise of four essential entities in the economic revitalization of the Great Lakes Region:

- K-12 school districts
- Higher education
- The renewable energy industry
- Informal science education sites



SUMMER INSTITUTE 2011 –Teacher Leader Fieldwork

Effective STEM Teaching with LEADERS

The LEADERS partnership shares a **vision of student-centered education that knits community economic growth with science education**. Specifically, teacher leaders and district level support personnel actively collaborate with university, industry, and informal science partners in the development of Project-Based Science (PBS) curricula that unites effective STEM education with community.

Project-Based Science & STEM Learning. PBS is one approach that addresses recommendations for science education by extensive use of student-directed scientific inquiry supported by technology and collaboration (Krajcik & Czerniak, 2007; Ruopp, 1993; Tinker, 1996).

PBS pedagogy is built around five activity features:

1. Engage students in investigating a real life question or problem that drives activities and organizes concepts and principles
2. Result in students developing a series of artifacts, or products, that address the question or problem
3. Enable students to engage in investigations
4. Involve students, teachers, and members of society in a community of inquiry as they collaborate about the problem
5. Promote students' use of cognitive tools (Krajcik, Blumenfeld, Marx, & Soloway, 1994).

The PBS approach, rich in science content/concepts connected to educational standards and anchored in real-world issues, provides evidence of scientific investigation from the classroom community. The active involvement in authentic data manipulation and further rounds of investigation provide for intellectual rigor, constructive criticism and the challenging of ideas. As a result, students produce a final, tangible product that is responsive to context and reflective of the continuous process that measures meaningful understanding. By involving students with members of society through real world issues, students learn about important scientific career possibilities.

<http://leaders.utoledo.edu/>

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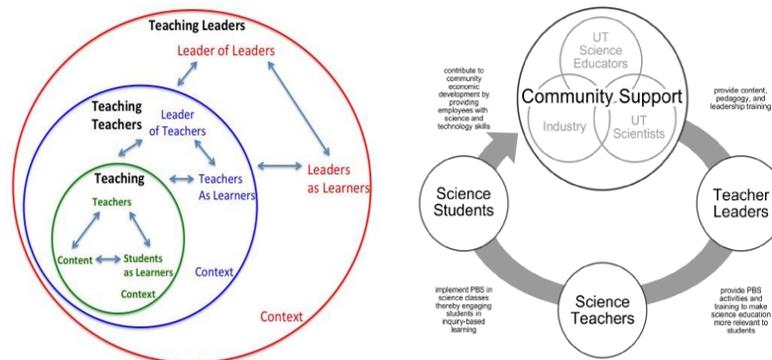
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STEM education improved through LEADERS approach

The goal of LEADERS is to improve science education by making it relevant to students through the incorporation of Project-Based Science (PBS) that is linked to the renewable energies industry and its environmental impacts - a vital element in the economic development of the Great Lakes Region.

LEADERS sustains science education reform through partnership collaboration. By the conclusion of the project, we expect to have 24 teacher leaders working in at least four large urban school districts and transforming the way science is taught to over 86,000 students annually in the Great Lakes Region.



Currently, the LEADERS community is encouraging and supporting the important inclusion of inquiry-based research projects in alternative energy in science education. For example, one of our Teacher Leaders used PBS inquiry to enhance her 4th-8th grade students' renewable energy learning experience and providing a real-world example of how PBS extends beyond the classroom walls to impact local communities. This specific use of PBS culminated in student presentations on local renewable energy recommendations made before the Crawford County (Ohio) Commissioners.



Recently, the LEADERS project has further illustrated the vital role of partnerships through a LEADERS community sponsored webinar to six schools. This program was successful in bringing challenges associated with the local green house industry to LEADERS affiliated students, teachers and scientists, who in turn could use PBS inquiry to explore recommendations for solutions to these real-world problems.

Recommended Resources

- Czerniak, C. M., Beltyukova, S., Struble, J., Haney, J. J., and Lumpe, A. T. (2005). Do you see what I see? The relationship between a professional development model and student achievement. In Exemplary Science in Grades 5-8: Standards-Based Success Stories, Ed. R. E. Yager. Arlington, VA: NSTA Press
- Krajcik, J., and Czerniak, C. (2007). *Teaching science in elementary and middle school*. New York: Lawrence Erlbaum.
- Ohio Academy of Science (2009). Alternative energy, the economy and STEM education top list of Ohio public policy concerns. Policy report: Author. Accessed online at <http://www.ohiosci.org/2009SciencePolicySurvey.pdf>, February 4, 2009.
- Ault, T., K. P. Czajkowski, T. Benko, J. Coss, J. Struble, A. Spongberg, M. Templin, and C. Gross (2006). Validation of the MODIS snow product (MOD10) and cloud mask using student and NWS cooperative station observations, Remote Sensing of Environment, 105, pp. 341-353.
- Loucks-Horsley, S., Love, N., Stiles, K. E., Mundry, S., & Hewson, P. W. (2003). *Designing professional development for teachers of science and mathematics*. Second Edition. Thousand Oaks, CA: Corwin Press.

LEADERS – Impacting Effective STEM Teaching

Teacher Leaders showed modest gains in the area of science teaching self-efficacy and baseline data on science teaching style preferences showed that as a group they preferred inquiry-based instructional strategies over non-inquiry based strategies (1.6 to 1 ratio). LEADERS professional development offerings are designed to further the skills and abilities of Teacher Leaders.

Teacher Leaders response to a survey rating the usefulness of professional development they attended:

	LEADERS	Other PD
What percent of the past year's total professional development activity was directly linked to your classroom instruction?	67	40
What percent of the past year's total professional development activity helped you learn new scientific inquiry techniques?	70	38
What percent of the past year's total professional development activity helped you implement new instructional strategies?	64	35
What percent of the past year's total professional development activity helped you learn new science content?	70	33
What percent of the past year's total professional development helped you learn to use new science and technology tools for the classroom?	59	37
Overall, what percent of what you have learned through the NSF LEADERS project is integrated in your classroom?	70	N/A

LEADERS is designed to perpetuate the gains in knowledge and experience of the Teacher Leaders by directly impacting district teachers through the professional development sessions. District teacher feedback was obtained through individual focus group interviews. Based on individual focus group interviews, all of the district teachers felt they benefited from the sessions, specifically:

- Gaining knowledge about energy, new vocabulary/terminology, and new equipment.
- Discovery through implementation of aspects of PBS that their own students lack essential problem solving skills needed for employment in science-related careers.
- Knowledge of and exposure to PBS implementation means district teachers are now more likely to take risks in the classroom.
- Appreciation of resources and supplies given to them by Teacher Leaders as well as interest in getting assistance in their class rooms from LEADERS community members.

Ultimately, the professional development sessions were well received and considered successful.

Challenges to Effective STEM Teaching

The project evaluation team utilizing the Horizon Observation Protocol, experienced difficulty determining the extent to which teacher leaders and district teachers have mastered project based science (PBS). While this Horizon instrument was designed to evaluate an inquiry-based science or mathematics lesson, it may not adequately assess the complexity of PBS mastery and therefore use of it alone to measure PBS may lack validity.

Frequency Count of PBS features included in Teacher Definition

Feature	Survey ¹	Interview Definition ²
Driving Question	3	8
Leamer Product	0	5
Investigation	0	6
Assessment	0	0
Cognitive Tools	0	0
Collaboration	4	4
Scaffolding	1	3
Extended Length	0	7
Student-driven	3	12
Real World	2	4

¹ Maximum score = 8

² Maximum score = 12

The Teacher Leaders were given a survey to assess their understanding of the definition (Interview Definition) of PBS and the eight accepted features of PBS; (1) driving question; (2) learner product; (3) investigation; (4) assessment; (5) tools; (6) collaboration; (7) scaffolding; and (8) length (Marshall, Petrosino, & Martin, 2010). The outcome of this survey demonstrated that, while the Teacher Leaders believed they understood PBS, in reality they did not have a firm grasp of PBS.