***L**eadership for **E**ducators: **A**cademy for **D**riving **E**conomic **R**evitalization in **S**cience* (**LEADERS**)
Award DUE-0927996

2009-2010 Year 1Annual Report

Kevin P. Czajkowski[1], Charlene M. Czerniak[1], Jan Kilbride[2]
[1]The University of Toledo
[2]Toledo Public School District

Activities and Findings

Project Activities:

Overview. The LEADERS Program achieved major accomplishments during its first year of funding. This report describes the activities that were completed to reach each of our evidence-based outcomes. First, the project goal and outcomes are stated. Each outcome is listed with the activities that were completed to achieve that goal. Printed material and snap shots of our websites are embedded within the report. The PowerPoint presentations mentioned in this document can be viewed from the LEADERS website: www.leaders.utoledo.edu.

Project Goal. 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, which is becoming a vital element in the economic development of the Great Lakes Region.

Evidence-Based Outcomes. The LEADERS outcomes are the following:
1) Develop a cadre of effective teacher leaders who transform science education by linking science content with emerging science-based industries in Great Lakes Region.
2) Increase the number of teachers in partnering districts who have strong content, pedagogy and leadership skills and knowledge.
3) Transform existing K-12 science courses to rigorous and relevant science courses through Project-Based Science (PBS).
4) Prepare K-12 students who can meet science and mathematics achievement standards and who become interested in science and technical careers.
5) Develop community science education networks that collaborate through the development and implementation of advanced or improved science courses.

Actions completed for each outcome.

1) Develop a cadre of effective teacher leaders who transform science education by linking science content with emerging science-based industries in Great Lakes Region.

In this section, we describe the teacher (and principal/administrator) selection process, enrollment of teachers in a degree program, the planning and implementation of the first summer institute, preliminary plan for academic year follow up, and the determination of treatment and control schools. All of these actions contributed to the development of our selected teachers as leaders for their districts.

*Teacher Selection***.** LEADERS PIs and school partners, Toledo Public (TPS) and Toledo Catholic (TCS) Schools, developed the application process that fit the needs of both districts. The school partners facilitated the distribution of information throughout their districts. For Toledo Public Schools, each school principal received a letter with flyers sent through the TPS mailing system. For the Catholic Schools, each principal received a letter with brochures and flyers sent through the electronic system used by the Toledo Diocese. Drs. Kevin P. Czajkowski and Charlene M. Czerniak gave presentations about the LEADERS Program to teachers and principals on the following dates: December 1, 2009; December 7, 2009; January 12, 2010, and January 13, 2010. Robert Mendenhall, TPS Director of Science Curriculum and Technology, presented information about the LEADERS Program and handed out LEADERS flyers at the department meetings in January 2010. The two sample flyers (Figure 1 and 2), brochure (Figure 3), and application (Figure 4) are below; The PowerPoint presentation is located at the following website: www.leaders.utoledo.edu/teacher_leader_program.aspx,

Figure 1. Sample Flyer

Figure 2. Sample Flyer

Figure 3. Program Brochure

Principal Investigators

Kevin Czajkowski Geography and Planning

Charlene M. Czerniak Science Education

Jan Kilbride Toledo Public Schools

Scientists and Engineers

Abdollah A. Afjeh Mechanical Engineer

Sorin Cioc Mechanical Engineer

Dean Giolando Chemist

Sanjay Khare Physicist

Patrick Lawrence Environmental Geographer

G. Glenn Lipscomb Chemical Engineer

Donald J. Stierman Geophysics Scientist

Science Educators

Mikell Lynne Hedley

Rolinda LeMay

Ann Novak

For more information

Janet Struble
LEADERS Program Coordinator
Phone 419-530-4993
Fax 419-530-4145
Janet.Struble@utoledo.edu
http://leaders.utoledo.edu

LEADERS is a partnership of the The University of Toledo (College of Arts and Science, Judith Herb College of Education & College of Engineering), Toledo Public Schools, Toledo Catholic Schools, Monroe County Schools, and Akron Public Schools.

Leadership for **E**ducators: **A**cademy for **D**riving **E**conomic **R**evitalization in **S**cience *(LEADERS)* is a mathematics and science partnership grant funded by the National Science Foundation.

The College of Arts & Sciences &
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LEADERS

Leadership for **E**ducators: **A**cademy for **D**riving **E**conomic **R**evitalization in **S**cience

> Learn exciting, cutting edge knowledge and skills

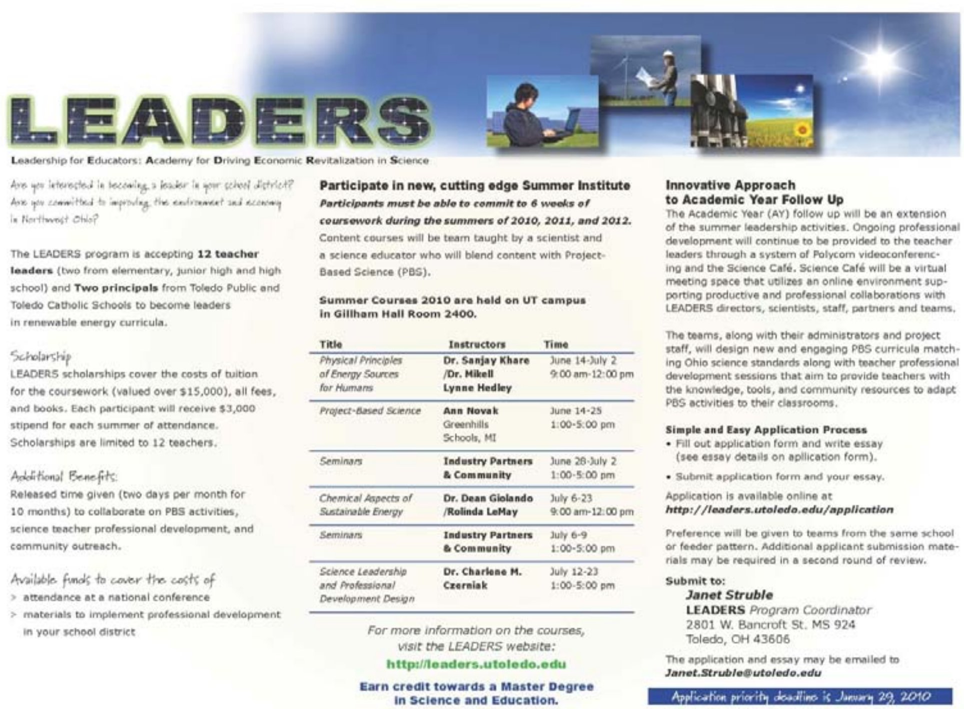
> Be a leader in integrating renewable energy concepts into your school's curriculum

> Help improve the Northwest Ohio economy with cutting edge content and leadership abilities

> Develop tomorrow's leaders in renewable energy

Application priority deadline is January 29, 2010

The College of Arts & Sciences &
The Judith Herb College of Education
at The University of Toledo



LEADERS

Leadership for **E**ducators: **A**cademy for **D**riving **E**conomic **R**evitalization in **S**cience

Are you interested in becoming a leader in your school district? Are you committed to improving the environment and economy in Northwest Ohio?

The LEADERS program is accepting **12 teacher leaders** (two from elementary, junior high and high school) and **Two principals** from Toledo Public and Toledo Catholic Schools to become leaders in renewable energy curricula.

Scholarship

LEADERS scholarships cover the costs of tuition for the coursework (valued over $15,000), all fees, and books. Each participant will receive $3,000 stipend for each summer of attendance. Scholarships are limited to 12 teachers.

Additional Benefits:

Released time given (two days per month for 10 months) to collaborate on PBS activities, science teacher professional development, and community outreach.

Available funds to cover the costs of

> attendance at a national conference

> materials to implement professional development in your school district

Participate in new, cutting edge Summer Institute

Participants must be able to commit to 6 weeks of coursework during the summers of 2010, 2011, and 2012.

Content courses will be team taught by a scientist and a science educator who will blend content with Project-Based Science (PBS).

Summer Courses 2010 are held on UT campus in Gillham Hall Room 2400.

Title	Instructors	Time
Physical Principles of Energy Sources for Humans	**Dr. Sanjay Khare /Dr. Mikell Lynne Hedley**	June 14-July 2 9:00 am-12:00 pm
Project-Based Science	**Ann Novak** Greenhills Schools, MI	June 14-25 1:00-5:00 pm
Seminars	**Industry Partners & Community**	June 28-July 2 1:00-5:00 pm
Chemical Aspects of Sustainable Energy	**Dr. Dean Giolando /Rolinda LeMay**	July 6-23 9:00 am-12:00 pm
Seminars	**Industry Partners & Community**	July 6-9 1:00-5:00 pm
Science Leadership and Professional Development Design	**Dr. Charlene M. Czerniak**	July 12-23 1:00-5:00 pm

For more information on the courses, visit the LEADERS website:

http://leaders.utoledo.edu

Earn credit towards a Master Degree in Science and Education.

Innovative Approach to Academic Year Follow Up

The Academic Year (AY) follow up will be an extension of the summer leadership activities. Ongoing professional development will continue to be provided to the teacher leaders through a system of Polycom videoconferencing and the Science Café. Science Café will be a virtual meeting space that utilizes an online environment supporting productive and professional collaborations with LEADERS directors, scientists, staff, partners and teams.

The teams, along with their administrators and project staff, will design new and engaging PBS curricula matching Ohio science standards along with teacher professional development sessions that aim to provide teachers with the knowledge, tools, and community resources to adapt PBS activities to their classrooms.

Simple and Easy Application Process

- Fill out application form and write essay (see essay details on aplication form).
- Submit application form and your essay.

Application is available online at
http://leaders.utoledo.edu/application

Preference will be given to teams from the same school or feeder pattern. Additional applicant submission materials may be required in a second round of review.

Submit to:

Janet Struble
LEADERS *Program Coordinator*
2801 W. Bancroft St. MS 924
Toledo, OH 43606

The application and essay may be emailed to
Janet.Struble@utoledo.edu

Application priority deadline is January 29, 2010

Figure 4. Application Form

LEADERS

Leadership for Educators: Academy for Driving Economic Revitalization in Science

Preliminary Application

Are you an energetic and passionate individual interested in integrating renewable energy concepts into the curriculum, developing tomorrow's leaders, and helping to improve the economy in Northwest Ohio?

12 teacher leaders (***two each*** from elementary, junior high and high school) and **TWO** principals will be selected to participate in the program from Toledo Public Schools and Toledo Catholic Schools. We are looking for individuals interested in taking on leadership responsibilities in their schools and who have strong science backgrounds and/or interest to create, test, refine and disseminate science curricula focused on renewable energy and to plan and implement district-wide projects.

1. Please fill in the following information and submit it with your application materials.

Name: ____________________

Current License and Grade Levels: ____________________

Subjects Currently Teaching: ____________________

Grade Level: ____________________

Are you currently enrolled in The University of Toledo's Graduate Studies? ☐ Yes ☐ No

School: ____________________

School Phone: ____________________

Home Address: ____________________

Home or Cell Phone: ____________________

Email Address (that you check regularly): ____________________

☐ A colleague in my school or within the same feeder is also interested in joining the LEADERS program.

Colleague's name and contact information: ____________________

☐ My principal is interested in joining the LEADERS program.

Principal Name: ____________________

LEADERS *APPLICATION* *1*

2. Submit an essay (no more than 5 pages typed, double spaced and use 10 or 12 point font) stating why you want to be in the LEADERS program. It is suggested that you include supporting evidence of previous leadership roles in the district, state or national recognition and/or awards as a teacher, participation in other teacher leadership projects, strong science background and/or interest in science, respect among peers, experience with adult learners, and commitment to the National Science Education Standards.

Submit to:

Janet Struble

LEADERS *Program Coordinator*

2801 W. Bancroft St. MS 924

Toledo, OH 43606

The application and essay may be emailed to ***Janet.Struble@utoledo.edu***

Priority deadline submission date – January 29, 2010

NOTE: *This is the preliminary application process. The full application* ***may*** *include, but not be limited to, the following:*

1) Science Teaching

- ☐ Observation of your science teaching.
- ☐ Provide a summary of your lesson plan and a reflective essay critiquing the lesson.
- ☐ Write an essay telling us your philosophy of teaching science.
- ☐ Submit a letter of recommendation from colleague or parent to support the evidence (listed above).

2) Leadership

- ☐ Describe the leadership roles you have played in general and in the fields of science and/or science teaching.
- ☐ Submit a letter of recommendation from a principal or administrator providing evidence of your leadership capabilities.

3) Academic rigor

- ☐ Describe your graduate level academic background and why you want to further your knowledge of renewable energy.
- ☐ Submit a letter of recommendation from a professor or person you have taken a class from providing evidence of your graduate level academic abilities.

***If you have any questions about LEADERS, call Janet Struble at* 419-530-4993.**

LEADERS website: ***http://leaders.utoledo.edu***

The selection committee comprised the following people: Kevin Czajkowski (UT scientist and coPI), Charlene M. Czerniak (UT science educator and coPI), Janet Struble (UT project coordinator), Jan Kilbride (TPS, Chief Academic Officer and coPI), Robert Mendenhall (TPS, Director of Science Curriculum and Technology), Cherie Pilatowski (TPS, TAPESTRIES Science (K-6) Support Teacher), Carolyn Jaksetic (TCS, Assistant Superintendent), Martha Hartman (TCS, Elementary School Consultant), and Lori Hauser (Imagination Station, Director of Operations). The committee developed a rubric for selection based on the following criteria: previous leadership roles within the district (e.g., department chair, special projects team leader, participation as a new teacher mentor), state or national recognition (Presidential Awardee or National Board Certification), participation in other teacher leader projects (such as prior NSF funded TAPESTRIES LSC project or UT NSF GK-12 project currently funded), strong science background, respect among peers, experience with adult learners, and commitment to the *National Science Education Standards* (National Research Council, 1996).

The committee reviewed 15 applications and made the final selection of the teachers and administrators on February 22, 2010. The selected participants include:

<u>Toledo Catholic Schools</u>

Teachers

Susan Bastian	Sylvania Franciscan Academy, Sylvania
Brooke Bradley	Rosary Cathedral Elementary School, Toledo
Susan Grod	All Saints Catholic School, Rossford
Kristin McKinley-Lynch	St. Francis de Sales High School, Toledo
Mary Ann Obringer	St. Bernard Catholic School, New Washington
Peggy Riehl	Gesu Elementary School, Toledo

Principal

*Timothy Mahoney	Cardinal Stritch High School, Oregon

* Timothy has subsequently been promoted to Curriculum Director for the entire Toledo Catholic Diocese.

Administrator

Martha Hartman	Elementary School Consultant

<u>Toledo Public Schools</u>

<u>*Teachers**</u>

Janice Bender-Benner	Lagrange Elementary
Elizabeth Buckholtz	Woodward High School
Theresa Paredes	Woodward High School
Ted (Gladwyn) Richardson	Toledo Technology Academy
Melody Tsapranis	Woodward High School
Jamie Youssef	Harvard Elementary School

* Due to the TPS budget, some of these teachers have subsequently been moved to a different building or have been laid-off and are awaiting word whether they will be rehired. .

Administrator

Robert Mendenhall	Director of Science Curriculum and Technology

*Degree Program***.** In the grant proposal, there were no plans for having the LEADERS courses culminate in a Masters Degree. Through various conversations with teachers, principals and administrators, it was evident that this was desired because the Masters Degree provides the teachers academic and financial incentives. Additionally, Ohio Licensure requires a teacher to obtain a Masters degree within 10 years of the date of initial licensure.

Kevin Czajkowski and Charlene M. Czerniak met with Patricia Komuniecki, Dean of The University's of Toledo College of Graduate Studies to explore the possibility of establishing a Master of Science and Education in renewable energy or having the courses count toward another Masters Degree program. The science courses for LEADERS program are based on the minor in Renewable Energy (21 credits). The courses expose students to content and quantitative analyses of the use of energy in human societies, its consequences, and environmental impacts with a primary focus on the advantages and complexities of introducing renewable energy resources. Establishing a Master of Science and Education in renewable energy at UT will take about two years through the Ohio Board of Regents processes. Until the new concentration is put in place, we enrolled the teacher leaders in a Masters of Arts and Education in Geography (an existing degree program).

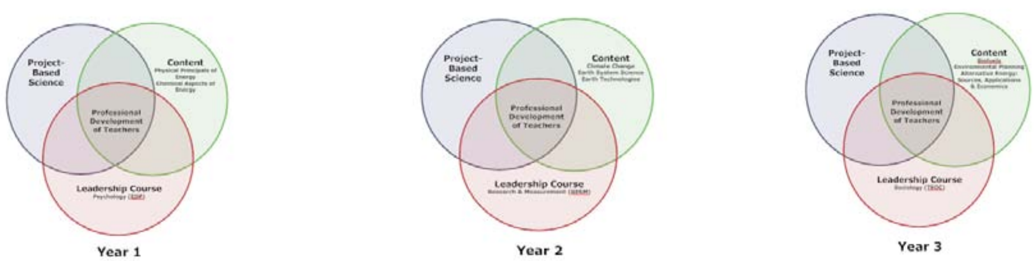
<u>Design of Leadership Classes</u>: After the meeting with the Dean of the College of Graduate Studies (stated earlier), the group explored ways in which the LEADERS program could count toward an existing Masters degree. The Masters of Arts and Education in Geography at The University of Toledo requires students to enroll in one course from each of the following areas in the Judith Herb College of Education: curriculum and instruction foundations (CI), psychological foundations (EDP), research foundations (RESM), and social foundations (TSOC). The PBS course counted toward the CI requirement. The leadership classes scheduled for years 1, 2, and 3 were designed to fulfill the EDP, RESM, and TSOC course requirements, respectively, by focusing on teacher leadership for student learning, high quality assessment and measurement of student outcomes, and diversity and equity.

The leadership class for the first year was created to answer the following driving question: How do project-based science and the science content come together to make you a leader in your school district? In Year 1, the Science Leadership and Professional Development Design focused on topics from a psychology perspective. For example, the leader teachers studied how people learn in general and specifically how students learn science. In the professional development sessions, student learning was linked to the features of project-based science that facilitate student learning and the pedagogical methods teachers would employ in the classroom. Other topics included learning from a cognitive point of view, motivation, change theory, and adult learning theory.

In Year 2, the leadership class will focus on leadership from a research and measurement perspective. The driving question for the course will be "How do you know your students are learning science?" For example, teacher leaders will gather evidence of student learning, analyze the results, and revise lessons and assessments to increase student learning. Teacher leaders will also learn how to analyze data from state and national science tests/assessments.

In Year 3, the leadership class will focus on topics from sociological point of view. The driving question will be "Are *all* students learning science?" The teacher leaders will focus on differentiating science instruction to meet the needs of all learners. Figure 5 illustrates the concept behind the organization of the courses:

Figure 5. Years One, Two, and Three Design



*Summer Institute***.** The LEADERS teachers will participate in three intensive summer sessions (2010, 2011, 2012) with academic year (AY) follow up that both reinforces and builds upon what has been accomplished in the summer institute. The summer institutes (6 weeks*) focus on the three areas essential to effective teacher leadership: content, pedagogy, and leadership.

* This is a design change from the original proposal that had the summer institute scheduled for 4 weeks.

The Summer Institute 2010 schedule was the following:

Title of Course	Instructors (scientist/educator)	Time
Physical Principles of Energy Sources	Dr. Sanjay Khare/Dr. Mikell Lynne Hedley	June 14-July 2 9:00 am-12:00 pm
Project-Based Science	Ann Novak Green Hills School, Ann Arbor, MI	June 14-25 1:00-5:00 pm
Seminars	Industry Partners	June 28-July 2 1:00-5:00 pm
Chemical Aspects of Sustainable Energy	Dr. Dean Giolando/Rolinda LeMay	July 6-23 9:00 am-12:00 pm
Seminars	Industry Partners	July 6-9 1:00-5:00 pm
Science Leadership and Professional Development Design	Dr. Charlene M. Czerniak	July 12-23 1:00-5:00 pm

<u>Content</u>

During the Summer Institute 2010, the two content courses were co-taught by a scientist and a science educator. Physical Principles of Energy Sources was taught by Dr. Sanjay Khare of the Department of Physics and Astronomy and Dr. Mikell Lynne Hedley, science education. Chemical Aspects of Sustainable Energy was taught by Dr. Dean Giolando of the Department of Chemistry and Rolinda LeMay, science education.

The team of scientists and educators planned lessons for the courses using the 5 E Learning Model (Bybee & Landis, 1988). The scientists, educators and their graduate assistants, along with Kevin Czajkowski and Janet Struble, met monthly starting in January. The lessons incorporated the inquiry-based activities that blended well with project-based science and latest technology available in the science education science laboratory including probeware, videoconferencing, document camera, and SmartBoard with a student response system (i.e., clickers). All sessions were recorded, video streamed, and available through archive to teachers immediately after the class. Teachers reported viewing the recorded sessions to further their understandings of the concepts and to prepare for tests. The 5 E lesson plans for each class session were posted in folders for each day of class in the *Science Café* (a virtual learning community, which will be described in more detail later).

Since the research in the content of both of these courses is ever changing, the scientists did not use books for the courses. Rather, all content information for the courses was uploaded to *Science Café*. A buddy system was set up to assist in the learning of the science content, especially for the elementary teachers. Scientists, with the help from their graduate assistants, identified tutorials and Internet resources (housed in the *Science Café*) to help teachers learn the science content. Scientists and graduate assistants were available before and after classes to teachers who needed extra help in learning the content.

The syllabi for the summer courses, Physical Principles of Energy and Chemical Aspects of Sustainable Energy, are provided below.

Syllabus:

LEADERS: Syllabus for Physical Principles of Energy
Summer 2010
The University of Toledo

Instructor: Sanjay Khare and Mikell Lynne Hedley
sanjay.khare@utoledo.edu
Mikell.hedley@utoledo.edu

Course Alpha Number: Phys 6980:001 To educate science teachers from elementary, middle and high schools on energy sources. Teachers taking this course are expected to teach other peers and thus create an army of schoolteachers knowledgeable in scientific principles governing energy supply and consumption.

The detailed course agenda is shown at the end of this document.

The course will involve the study of various conventional and unconventional sources of energy for human consumption. These will include conventional sources such as food (including agricultural, horticultural, and hunting sources), plant produce (wood, grass), animal power (horses, oxen and others), fossil fuels in solid (coal), liquid (crude oil), and gas (natural gas) forms. Alternative sources will include hydroelectric, wind, solar photovoltaic, solar thermal, solar-thermal-electric, tidal and wave, geothermal, thermoelectric, bio-diesel, bio-ethanol, nuclear, and human and industrial waste. Each source of energy will be analyzed using a variety of criteria such as the physical mechanism of energy production, world-wide abundance, energy returned on energy invested, continuity of flow (dispatch-ability), convenience, safety, environmental pollution (including visual, audio, chemical, and biological), portability, peak power, and storage. Emphasis will be on making quantitative analyses on scientifically established principles and data.

The following forms of energy will be explored in this course.

1. Fossil-Solids: Coal
2. Fossil-Liquids: Crude Oil, Natural Gas Liquids
3. Fossil-Gas: Natural Gas
4. Nuclear: Fission mostly with some fusion
5. Hydroelectric: Large scale and small scale dams
6. Wind: Different forms offshore and on shore and different scales
7. Solar: Photo-voltaic, solar-thermal-electric, and solar thermal
8. Geothermal: For heating and electricity generation
9. Biomass (not used for food): This will include wood, grass, human and animal waste, different types of ethanol by source, bio-diesel from oil-seeds
10. Wave and Tidal
11. Food: Agricultural, horticultural, and hunting produce.
12. Animal Power: Horses, bullocks and others
13. Conservation: Effect of energy flow during waste re-cycling, waste heat, burning industrial waste for energy

The following energy storage and transmission devices will be considered

1. The Electric Grid
2. Water reservoirs
3. Compressed Air
4. Batteries
5. Hydrogen and other fuels
6. Ultra-Capacitors
7. Human and Animal Fat and muscle

The study of each of the above 13 primary sources and 7 storage devices will be conducted with a description of the following attributes.

1. The physical mechanism for energy extraction and its relationship to the four fundamental forces found in nature
2. The total resource base and reserve base available
3. The net surplus energy, or energy returned on energy invested
4. The portability of the source

5. Rate of Flow
6. The fungibility
7. Continuity of Flow
8. Convenience and Safety
9. Infrastructure requirements
10. Pollution: Chemical, biological, audio, and visual

Table of examination schedule

Examination name and weight in letter grade	**Day and Date**	**Time and Classroom**	**Syllabus**
First, 10%	Monday, 21st June 2010	9:00 - 10:00 a.m., GH 2400	Chapters 1 and 2
Second, 10%	Monday, 28th June 2010	9:00 - 10:00 a.m., GH 2400	Chapters 3, 4, 5, 6 and 7
Final, 20%	Friday, 2nd July 2010	9:00 - 11:00 a.m., GH 2400	Entire course syllabus

Table of course agenda

Day number:	**Topics**	**Reading**
1. Monday, 14th June 2010	[Pre Test] General Overview	 Chapter 1, section 1.1
2. Tuesday, 15th June 2010	General Overview	Chapter 1, sections 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7
3. Wednesday, 16th June 2010	Coal	Chapter 2, sections 2.1, 2.2, 2.3, 2.4 and 2.5
4. Thursday, 17th June 2010	Coal	Chapter 2, sections 2.6, 2.7, 2.8, 2.9, 2.10 and 2.11
5. Friday, 18th June 2010	Coal Oil	Chapter 2, sections 2.12, 2.13 and 2.14 Chapter 3, section 3.1
6. Monday, 21st June 2010	[First Exam] Presentations on Phase I of Project Oil	Chapter 3, sections 3.2,3.3 and 3.4
7. Tuesday, 22nd June 2010	Oil	Chapter 3 section 3.5 Chapter 4 sections 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6

8. Wednesday, 23rd June 2010	Oil Nuclear	Chapter 4, sections 4.7, 4.8, 4.9, 4.10 and 4.11 Chapter 5, section 5.1
9. Thursday, 24th June 2010	Nuclear Hydro	Chapter 5, sections 5.2 and 5.3 Chapter 6
10. Friday, 25th June 2010	Wind Solar	Chapter 7 Chapter 8, sections 8.1 and 8.2
11. Tuesday, 29th June 2010	[Second Exam] Solar Geothermal	 Chapter 8, section 8.3 Chapter 9
12. Tuesday, 29th June 2010	Biomass	Chapter 10
13. Thursday, 1st July 2010	Dr. Kevin Czajkowski	
14. Friday, 2nd July 2010	[Final Exam] Dr. Kevin Czajkowski	
15. Friday, 2nd July 2010	Presentations on Phase II of Project	
Friday, 9th July 2010	Physics Concept Map	
Tuesday, 13th July 2010	Submission of Phase III of Project	
Thursday, 30th September 2010	Submission of Phase IV of Project	

Syllabus:

LEADERS: Chemical Aspects of Sustainable Energy Summer 2010
The University of Toledo

Instructor: Dean Giolando and Rolinda LeMay
Dean.giolando@utoledo.edu
Rolinda.lemay@utoledo.edu

Course Alpha Number: GEPL-6930-001

1. **Role of Chemistry in Sustainable Energy Systems**
   - Origin of the elements
   - Binding of electron to the nucleus
   - Formation of covalent bonds

2. **Carbon, Hydrogen and Oxygen Bonds**
   - Water, carbon and nitrogen cycles
   - Organic chemistry found on the Earth's crust
   - Natural polymers in nature

3. **Chemistry Behind Recycling and Reuse**
   - Abundance of the elements in the universe and Earth's crust
   - Common minerals
   - Production of silicon and aluminum metals
     - Aluminum recycling
   - Plastics recycling

4. **Advantage and Disadvantages of Biomass and Fossil Fuels**
   - Bio –molecules, organic compounds in living systems
     - Precursors to fossil fuels
   - Breaking down the organic material to bio-fuels

5. **Fuels of Today and into the Future**
   - Gasoline from oil
   - Diesel from Syn gas (CO/H_2)
   - Methane, propane and butane
   - Ethanol and butanol
   - Electricity?

6. **Hydrogen as a fuel**
   - Production of H_2; from coal, methane or water

7. **Solar Photovoltaics**
   - How solar cells work to generate electricity
   - Si
   - CdTe
   - $CuInSe_2$

8. **Solar Photovoltaics**
   - TiO_2 based
   - Earth Abundant
   - Nano technology
   - Organic devices

9. **Solar Thermal**
   - How to make use of the thermal heating properties

10. **Nature's Sources of Energy**
    - Photosynthesis
    - Hydrogenases

11. **Wind, Chemistry of the materials used**
    - Polymers and carbon composites
    - Carbon nanoutbes

12. **Chemistry involved in Geothermal and Ocean Resources**
    - Scale deposits
    - Dealing with bio-responses

13. **Nuclear**

Sources of fuel
Refinement of ores
Reclamation of spent fuels
Advantages/Disadvantages

Assessment *(syllabus subject to change and modification by the instructor as required)*

- Daily quiz of three questions from the previous day's material.

- Post-assessment examination on last day, for comparison to the pre assessment examination.

- Participation on a daily basis on constructing the Concept Maps.

- Completion of the Concept Maps in August (or end of course).

- Form an outline of a potential Project Based Science Unit, and in their outline provide one complete lesson plan with details of the *content* background due September 30.

Pedagogy. Ann Novak, a teacher who uses project-based science principles everyday in her classroom at Greenhills School in Ann Arbor, Michigan, was the instructor of the Project-Based Science course. The books for the course included: *Teaching Science in Elementary and Middle School: A Project-Based Approach* (2007) co-authored by Joseph Krajcik and Charlene M. Czerniak, and *Inquiry and the National Science Education Standards* (National Research Council, 2000). Investigating and Questioning the World through Science and Technology (iQWST) and Project Based Inquiry Science (PBIS) curriculum materials (Energy unit) developed through an NSF-funded project were included as examples of model PBS curricula (Krajcik, McNeill, & Reiser, 2008). Ms. Novak worked with Charlene M. Czerniak and Joe Krajcik to plan the course. She provided real-world examples from her own junior high science classroom to illustrate the use of PBS to teach energy concepts. Through the building of Rube Goldberg devices, the teachers explored and explained the energy transformations of the devices they created.

Syllabus:

LEADERS: Project-Based Science (PBS)
Summer 2010
The University of Toledo
Course Alpha Number: CI 5980/7980

Instructor: Ann M. Novak
anovak@greenhillsschool.org
734-665-6455 (hm)
734-649-6114 (cell)

COURSE OVERVIEW
Designed for Elementary, Middle, and High School Teachers, this course will focus on helping you learn how to teach science using a Project-Based approach. This approach engages all learners in exploring important and meaningful questions through a process of investigation and collaboration. Embedded in these questions are important science ideas that are investigated using scientific practices. Students do the same activities that scientists do. As a result students develop integrated understanding of science.

COURSE GOAL

The major course goal is to provide you with experiences and tools to help you develop the knowledge that will allow you to develop units and teach using the Project-Based Science framework. The course goals include the following:

1. Delve deeply into the various features of PBS.
2. Carry out a long-term investigation to illustrate and experience, first hand, the various PBS features.
3. Carry out smaller investigations and engage in various scientific practices.
4. Provide ideas and many examples related to energy that may assist you in designing your own PBS unit.
5. Provide you with planning time: Finish the class with a project skeleton that you can build on throughout the summer.

COURSE ACTIVITIES AND EVALUATION

You will be assessed based on the following:

1. Engagement in class activities and discussions. 50pts.
2. Completed in-class assignments. 50pts.
3. Completed homework assignments. 50pts.
4. Rube Goldberg Assignment. 50pts.
5. Energy Resource Research assignment: What does a Rube Goldberg machine have to do with energy in my home? 30pts.
6. PBS Unit Skeleton 70pts.

Daily Overview

Day	Goal
Monday, June 14	Introduce PBS Identify energy concepts using AAAS Atlas, NSES Standards, Ohio Standards. Identify Inquiry Standards and 21st Century Literacy/Skills Introduce Learning Goals PBS feature: Contextualization Contextualization activity
Tuesday, June 15	Contextualization: Anchoring activities Long-term investigation: Introduce Rube Goldberg Machine Plan and begin to build Debrief
Wednesday, June 16	How Children Learn Rube Goldberg building Begin to introduce/explore energy types Representation of energy: energy conversion diagrams Formative Assessment activity
Thursday, June 17	Formative Assessment Explore energy types PBS Feature: Investigation Learning performances Anchoring Activities Driving Questions Planning time: Teacher PBS units Re-design of Rube Goldberg: plan and work time Debrief Begin: Project ideas for teacher units
Friday, June 18	Project ideas: Share/feedback Energy Transfer: Where does energy go when an object stops? Introduce/explore energy types Making connections across lessons

	Project work time PBS feature: Creating a community of learners Collaboration Classroom Discourse
Monday, June 21	Introduce/explore energy types Energy Transformation Diagram examples Rube Goldberg Machine – work time: building and transformation diagrams PBS feature: Technology Teacher project – work time Debrief
Tuesday, June 21	Introduce/explore energy types Complete and present Rube Goldberg Machines PBS Feature: Artifacts/assessment Debrief: Backwards design Project design – work time Clean-up Rube Goldberg machines
Wednesday, June 22	What does a Rube Goldberg machine have to do with energy in my home? Energy Resource Assignment Debrief: Connections across the curriculum
Thursday, June 23	PBS feature: Scientific Explanations Project work time
Friday, June 24	Re-cap features of PBS Project work time Presentations of teacher PBS project skeletons Wrap up: connections back to day one PBS class evaluation

Leadership. While three-fourths of the summer program concentrated on science content and its application through PBS, the other fourth of the program was devoted to developing leadership skills. We followed the PRIME Leadership Framework (National Council of Supervisors of Mathematics, 2008) that states that effective teacher leaders need three areas of expertise: technical (pedagogy and content that promotes adult learning), managerial (understanding how to make use of the existing organization and resources), and sociopolitical (understanding how to maintain networks to sustain improvement) in the planning of the course *Science Leadership and Professional Development*. Topics covered in this portion of the Institute included community resource mapping (Crane & Mooney, 2005), social networking using web-based technology (Sawchuk, 2008), grant writing and external funding, engaging in action research as a means of inquiring into one's own practice, adult learning techniques, engaging poli-influential people in the community, and group process. Informal science educators will provide insight as to gaining community support for science programs as well as share community resources.

Charlene M. Czerniak established a team, which included Dawn Wallin (a former principal), Lacey Strickler (a former informal educator and current graduate assistant), Nithya Doraiswamy (a graduate assistant), and Janet Struble (former science teacher and professional development provider) who met biweekly beginning in January to develop the leadership course. The graduate assistants and Czerniak read over twenty books on leadership in the fall; the group evaluated the list and determined the books that were used in the class. The major sources used in the planning of this courses were the following: *How People Learn* (2000) by the National Research Council, *Designing Professional Development for Teachers of Science and Mathematics* (2003) co-authored by Susan Loucks-Horsley, Nancy Love, Katherine Stiles, Susan Mundry, and Peter Hewson, *Teacher Leadership in Mathematics and Science: Casebook and Facilitator's Guide* (2000) co-authored by Barbara Miller, Jean Moon, and Susan Elko, *Awakening the Sleeping Giant: Helping Teachers Develop as Leaders* (2009) co-authored by Marilyn Katzenmeyer and Gayle Moller, and *How to Thrive as a Teacher Leader* (2005) by John Gabriel. The texts used by the teacher leaders were the following: *Awakening the Sleeping Giant: Helping Teachers Develop as Leaders* (2009) co-authored by Marilyn Katzenmeyer and Gayle Moller, *How to Thrive as a*

Teacher Leader (2005) by John Gabriel and *How Students Learn: Science in the Classroom* (2005) by National Research Council.

Syllabus:

Course Title: Basic Educational Psychology: Science Leadership & Professional Development Design I

Year: Summer 2010

Course Alpha Number: EDP 5110/EDP 7110

Instructor: Dr. Charlene M. Czerniak

419.530.2094
Charlene.Czerniak@utoledo.edu*
*email preferred over voice mail

Credit Hrs: 3

Dates: July 12- 23, 2010

Course Location: Gillham Hall Science Lab

Time: M-F 1:00-5:00 p.m.

A. Course Description

The National Science Education Standards [*The Standards*] (NRC, 1996) contain “Standards for Professional Development of Teachers of Science.” The primary rationale in *The Standards* is that professional development for a teacher of science is a continuous, lifelong process. These *Standards* suggest that the traditional distinctions between targets, sources, and supporters of teacher development are artificial. The conventional view of professional development for teachers needs to shift from technical training for specific skills to opportunities for intellectual professional growth. The process of transforming schools requires that professional development opportunities be clearly and appropriately connected to teachers’ work in the context of the school. *The Standards* for professional development are composed of four separate standards:

- Standard A: Professional Development for teachers of science requires learning essential science content through the perspectives and methods of inquiry,
- Standard B: Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students: it also requires applying that knowledge to science teaching,
- Standard C: Professional development for teachers of science requires building understanding and ability for lifelong learning,
- Standard D: Professional development programs for teachers of science must be coherent and integrated.

Among other things, *The Standards* call for a change in emphases for professional development. One change shifts the focus of professional development from that of reliance on external expertise to a mix of internal and external expertise. This shift suggests that staff developers are no longer “educators who deliver professional development to teachers” but rather facilitators, consultants and planners. The teacher is less a “technician” and more an intellectual, reflective practitioner who is a producer of knowledge about teaching. The teacher is less a follower and more a leader who is a member of a collegial professional community. The teacher is no longer the target of change but the source and facilitator of change.

National reports call for a cadre of science education leaders and professional development designers. These reports urge that these people are not “external experts” but rather teachers and curriculum leaders in the context of the school. Therefore, there is a need to provide educators with the specialized knowledge needed to become leaders and professional development designers in school districts.

This course is designed to help science teacher leaders develop and implement teacher professional development aimed at improving teaching and learning in K-12 schools. The course focuses on designing high quality professional development consistent with psychological principles of student learning of science, developing teachers’ leadership skills, gaining skills needed to deal with school reform and change, and gaining an increased understanding of adult learning principles needed to work with peers as a teacher leader.

B. Specific Course Outcomes

Students in the class will:

LEADERSHIP

Develop a personal definition of a teacher leader.

Determine what their philosophy of education is and how to lead other teachers with different philosophies.

Discuss and role-play a scenario in which they will need to determine how to communicate feedback to peers when trying to implement new teaching experiences.

Learn that there are different types of leadership.

Assess their leadership style.

Determine the kinds of expertise needed to instruct their colleagues and reflect on the resistance they may encounter.

CHANGE

Using the knowledge of change theory on an individual level, the learner will create implementation strategies that will be use in professional development sessions with district teachers.

The learner will apply one’s knowledge of organizational change by beginning to develop an action plan that addresses the following questions:

- What needs to happen for the science teachers at your school to adopt Project-Based Learning?
- What needs to happen for the principal at your school to adopt Project-Based Learning?
- What needs to happen for your district to adopt Project-Based Learning?

PROFESSIONAL DEVELOPMENT

Create a rough outline of their professional development session.

Evaluate a professional development session with a provided rubric.

Identify strategies to use while implementing their professional development.

HOW STUDENTS LEARN SCIENCE

Understand how students learn science.

Be able to address student preconceptions in science.

Understand what it means to "do science."

Understand metacognition in science teaching.

Teach to promote the development of scientific knowledge and reasoning.

Support learning through cycles of investigation.

Understand role of subject-specific knowledge in effective science instruction.

Use scientific inquiry in the science classroom.

Developing understanding through model-based inquiry.

ADULT LEARNING

Understand how teacher leaders identify areas of adult learning.

Understand how teacher leaders incorporate peer learning in professional development using Adult Learning theory.

Understand how teacher leaders create a new professional development using a Project Based Science (PBS) framework and Sustainable energy content for peers utilizing adult learning principles.

Be able to create a new professional development using PBS framework and sustainable energy content for peers incorporating group processes concepts.

Be able to identify conflicts in peer learning in professional development.

Be able to resolve conflicts in peer learning in professional development using conflict management techniques.

C. Attendance Policy

Students are expected to attend all classes. The student's final course grade will be reduced 10% for each unexcused absence. For more information, students should refer to The University of Toledo policy on absences at: http://www.utoledo.edu/facsenate/missed_class_policy.html

E. Method of Course Evaluation

Attendance and active class participation – 20%
Assignments posted on Science Café – 10%
Final project – 70%

Additional Doctoral Level Requirement: Summarize the research in *How Students Learn Science in the Classroom* and prepare a PowerPoint presentation of the summary to be given to the class on the last day of the summer institute explaining how the student learning theory fits with concepts learned this summer in the LEADERS institute.

F. Required Books

National Research Council (2005). *How students learn science in the classroom.* National Research Council: Washington, DC.

Katzenmeyer, M., & Moller, G. (2009). *Awakening the sleeping giant*. Corwin: Thousand Oaks, CA.

Gabriel, J. G. (2005). *How to thrive as a teacher leader*. Association for Supervision and Curriculum Development: Alexandria, VA.

References:

National Research Council. (1996). National Science Education Standards. Washington, D.C.: National Academy Press.

*Seminars***.** In concert with the courses described above, UT scientists and researchers, local business leaders, local college representatives, and area industry representatives were solicited to participate in seminars that linked the science content to practical applications and community resources that gave the teacher leaders information to bring relevance to their science classrooms. The school partners, along with LEADERS PIs, brainstormed a potential list of speakers and UT facility or business tours at meetings in April and May. The seminars were focused around a theme (in bold in the seminar schedule). Each presenter was asked to provide a short biography with contact information and to address the following questions in his/her presentation:

1. What does your department/company do/produce and how is your service/product related to renewable energy?
2. How does your company fit into the economy of NW Ohio and contribute to the economic revitalization of the community?
3. What knowledge and skills do the students of these teachers need in order to work at your company?

The overall driving question for the seminar speakers was “How will you prepare your district’s students for tomorrow’s jobs?” with the driving question for each day “How will you apply the knowledge that you learned from today’s seminar in your classroom and the professional development you will design for your district?” These questions were stated at the beginning of the afternoon sessions. The teacher leaders were required to reflect on each day’s presentation(s) in an electronic journal (on *Science Café*) by addressing the following questions: “How will I apply what I learned today?” (The “how” should include the “what” – the information and/or skills) and “What elements of PBS help prepare students for jobs in their future?” Teachers were given time to do this at the end of the afternoon session.

The first seminar session, Preparing Today’s Students for Tomorrow’s Jobs, reiterated the goal and outcomes of the LEADERS program, explained how the seminars addressed them, and set the stage for the next two weeks. On Friday, July 2, Rick Mangini from the Ohio Department of Education spoke to the teacher leaders via video-conferencing from Columbus. He provided an overview of Ohio’s efforts to prepare students with 21st Century Skills. Through an active dialogue, teacher leaders had a better understanding of what will be expected of them in the future and how project-based science curriculum fits into the development of the 21st Century Skills. After the presentation, the teacher leaders were given the task of creating video podcasts to inform their districts of 21st Century Skills. Storyboards were developed, critiqued, and revised. Teacher leaders will be using their students in their schools to produce the podcasts in the fall. A complete listing of the seminars is in Table 1 below. On Thursday, July 8, wrap-up and closure for the seminars was conducted after Mr. Richardson’s presentation. Teacher leaders were asked to identify a seminar presentation and share with others in the class their reflection for that presentation, which was in their electronic journal.

Table 1.

Seminar Schedule for Summer Institute 2010

Monday, June 28	**Preparing Today’s Students for Tomorrow’s Jobs**
Mary Jo Waldock UT Innovation Enterprises	The Importance of Innovation & Science Education to the Future of our Economy and Region
Joseph Peschel	Owens Community College Solar Installer Program & Other Training

Owens Community College Coordinator of Customized Training	Opportunities in Renewable Energies
Tuesday, June 29	**LEADERS Business Partners and their Roles**
Milt Baker CEO	Blue Water Satellite, Inc.
Gale Tedhams Director of Sustainable Communities & Green Products– Owens Corning	Winning with Green Tour of Owens Corning International Headquarters
Wednesday, June 30	**Sustainable Energy in Action**
Tim Mayle Hardin County GIS Coordinator	Applying GIS in Wind Energy Development
Thomas Brady Dean of Judith Herb College of Education	Preparing 21st Century Teachers
Kenneth Kilbert UT Associate Professor of Law	Climate Change and the Law
Thursday, July 1	**Sustainable Energy in Action Tours**
Amanda Gamby Environmental Educator	Tour of Bowling Green Wind Farm
Chris Downey Sales Manager Stark's Inc.	Green by Design: Presentation on Green Construction Materials Company Overview & Showroom Tour
Friday, July 2	**Preparing Students for 21st Century Skills: A State's Perspective**
Richard Mangini Ohio Dept of Education Career & Technical Education	Preparing Today's Students for the Jobs of Tommorrow: What Ohio Businesses Want
Tuesday, July 6	**Incorporating Sustainable Energy on UT campus and in NW Ohio**
Megan Reichert-Kral Director Clean Energy Incubator	Clean Energy Incubator Tour of Clean Energy Incubator on UT campus
Chuck Lehnert Vice President UT Facilities & Construction	UT *Green* Facilities: Applying the Research Tour of Scott Park Campus
Wednesday, July 7	**The Many Facets of Economic Development**
Steve Weathers President & CEO Regional Partnership Growth & Rocket Adventures	The Role of Sustainable Energy in the Revitalization of Northwest Ohio
Neil Reid Director UT Urban Affairs	Perspectives on Economic Development in Northwest Ohio
Thursday, July 8	**NW Ohio Projects & Student Projects relating to Sustainable Energy**

Alan Bowen Project Manager Advanced Distributed Generation LLC	Solar Project for the Green Belt Parkway
Ted Richardson Teacher Toledo Technology Academy	Renewable Energy Projects for Students
Friday, July 9	**LEADERS Evaluation, Your Research, and Your Concerns**
Gale Mentzer *Lisa Brooks* LEADERS Evaluators	LEADERS Evaluation regarding district teachers
Kevin Czajkowski	Brief Overview of Thesis requirements
Elaine Reeves *Mark Horan* *Daniel Feinberg* UT Libraries-Carlson Library	Using UT Resources in your Research
Kevin Czajkowski *Charlene M. Czerniak*	Miscellaneous Concerns

In addition to the planned speakers, we were fortunate that The University of Toledo President, former UT President, and Vice President for Research invited a national expert on alternative energy to speak at UT and receive an honorary doctoral degree. Our teachers were able to hear this exciting speech on Thursday, July 22. Dr. Sultan Al Jaber, a world-wide expert on alternative energy from the United Arab Emirates (UAE), is chief executive officer of the Abu Dhabi Future Energy Co., which is mandated by the government to drive the Masdar Initiative that is Abu Dhabi's multifaceted program to develop and commercialize renewable energy technologies. The centerpiece of the initiative is the well-known Masdar City, which is a carbon-neutral, zero-waste municipality.

Science Café. To facilitate communication and social networking among teacher leaders (between and within school districts), project staff, and supporting partners, an innovative element of LEADERS was developed and called *Science Café*. The *Science Café* is a virtual meeting space that utilizes an online environment supporting productive and professional collaborations. The *Science Café* was created using Microsoft's *SharePoint* program licensed through the University of Toledo. After exploring over 30 web based applications, LEADERS PIs and staff used a trial version of *SharePoint* for 3 months to determine its functionality and ease of use for teachers, many of whom have low level technical skills, before making the final decision. With Gary Powell, technical support director, taking the lead, the staff first developed the design and the components of the *Science Café,* and then sought for input from all parties (including professors and educators teaching content). During the summer institute, the teacher leaders were also asked to provide feedback regarding the format and ease-of-use of the *Science Café*.

The *Science Café* (see sample home page in Figure 6) provides a location for each course: Physical Principles of Energy Sources, Project-Based Science, Chemical Aspects of Sustainable Energy, and Science Leadership and Professional Development Design. *Science Café* contains a site used for the planning of the Leadership class as well as a site for evaluation. The team planning the leadership course decided to test the usage of the *Science Café* in order to provide feedback to Gary Powell, technical support director. The sites are listed along the left side and across the top. The "Home" page contains information that may be used in the course content courses. Areas of the *Science Café* were set up to facilitate teacher collaboration including "The Problem Solver," "Nagging Questions," and "Teachers' Lounge."

All classroom sessions and most of the seminars were video recorded and are housed in a web space entitled *A Learning Community of Teachers* (ALCOT) (Figure 7). Teachers could also access the videos from *Science Café* under "Lecture Stream." The classes were video-streamed live for anyone to see. For example, external evaluator, Janice Koch, viewed the classes from New York. The teachers reported that they viewed the classes from home to replay a lecture to further their understanding of the content and to study for tests and exams. The teacher leaders will also be able to use any parts of the videos when they conduct their professional development.

Figure 6. Main Page of the *Science Café*

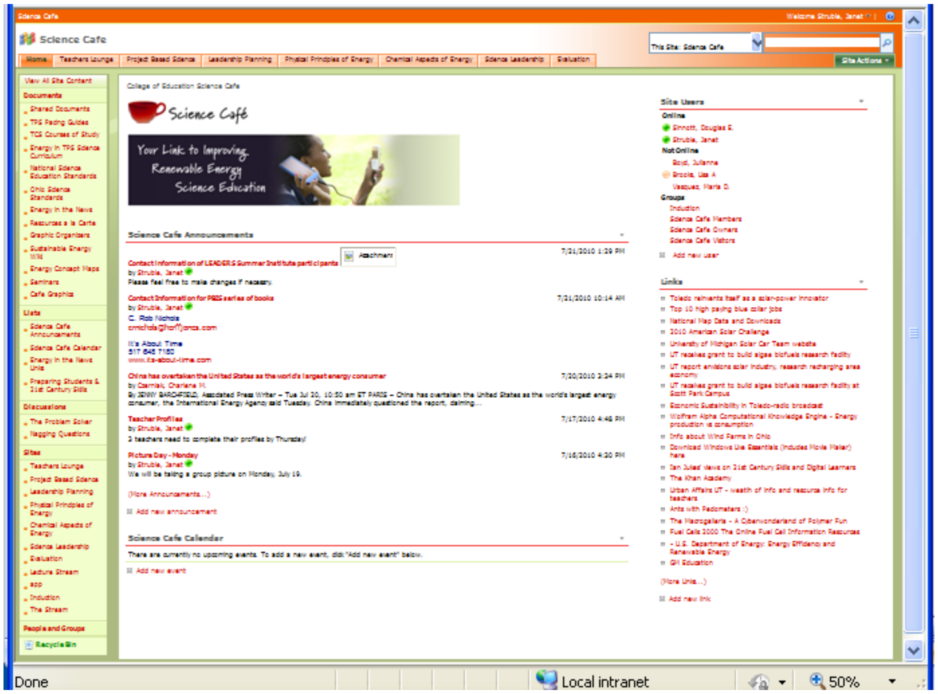


Figure 7. ALCOT (A Learning Community of Teachers) Website

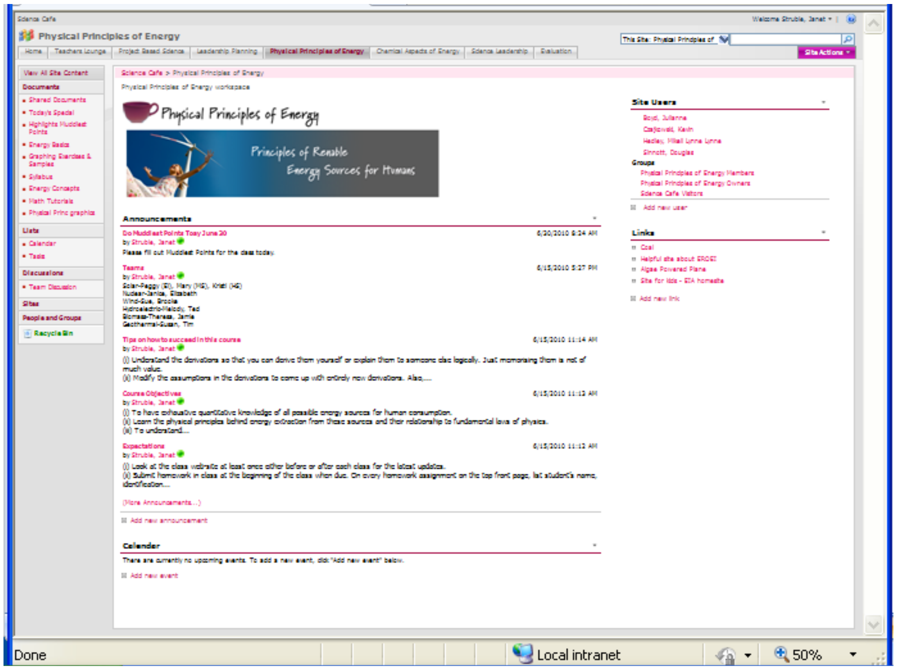
Each course website contained the following components (see Table 2):

Table 2.

Course Website Components

Location	**Web part**	**Description of Contents**
Documents	Shared Documents	Place where teachers can post and edit documents; hand in assignments
	Today's Special	Site housing a folder for each day of class. The instructors post any and all documents used in class such as lesson plan(s), PowerPoint(s), graphic organizer(s), web links, etc. Teachers upload any assignments due that day in the folder.
	Muddiest Points	Documents filled in and uploaded by the teacher leader to inform instructors on points that need clarification
	Energy Basics Graphing Exercises Math Tutorials	Documents/sites added by the instructors to assist in the learning of content of the course
	Syllabus	Folder containing the syllabus for the course to provide easy access to refer to assignments, etc. Assignments are also posted on the calendar.
Lists	Calendar	Area for anyone in the course to post important dates pertaining to the course
	Tasks	Place where tasks can be assigned and monitored
Discussions	Team Discussions	Location where participants can discuss topics
Sites		Place to create a new list, library, discussion board, survey, page or site
Announcements		Site where anyone in the course can post an item for the group to know
People and Groups		List of people who have access to the course site
Site Users and Groups		Place group members and who is online within the *Science Café*
Links		Website links that contain information pertinent to the course

Figure 8. Main page for Physical Principles of Energy



The teacher leaders have site permission to add or delete items within the sites so the *Science Café* becomes useful to them. The consistency of look, location of objects, and documents filed in folders facilitated easy use of the *Science Café* by everyone involved in LEADERS.

Each teacher leader received a Dell laptop computer (purchased from indirect overhead funding from the grant) to minimize any issues dealing with technology such as not having computer programs or updated versions of programs needed to complete the course work and implement the professional development. The teacher's laptop is a Dell Latitude L13with 13.3 inch Widescreen containing Intel Centrino 2 Core Duo Processor, Mobile Intel Graphics Media Accelerator videocard, 160GB Hard Drive, 2.0GB memory, 1.3MP web camera, power cord, and external CD/DVD drive. The Dell computer contains the full suite of Microsoft Office programs and *Inspiration* (program used to create concept maps).

2) ***Increase the number of teachers in partnering districts who have strong content, pedagogy and leadership skills and knowledge.***

In the above section, we discussed how the teacher leaders received intense professional development in strong content, pedagogy and leadership skills and knowledge while engaged in the Summer Institute 2010. Since this is the first year of LEADERS, the teachers have not performed their professional development for district teachers and therefore we have not worked with teachers in the districts at this time. The section describes our plan for academic follow up with our teacher leaders and dissemination of professional development for district teachers.

Academic Year Follow-Up. The Academic Year (AY) follow-up will be an extension of the summer leadership activities. Teacher leaders will be given two days per month for 10 months to collaborate on PBS activities, science teacher professional development, and community outreach. During this time, teacher leaders will meet as one group to continue the work that was started in the summer institute. Teacher leaders will teach their PBS lessons in the fall in their own classrooms in order to become proficient in project-based science. During the summer institute, teacher leaders identified content and grade levels (3, 5, 6, 9, and 11) to target during the first year. These grade levels were selected because they contain the most sustainable energy related concepts. The professional development plan for the district teachers started during the summer will be finished in the fall semester.

LEADERS PIs recognized that it is unrealistic to expect teacher leaders alone to accomplish the daunting task of transforming science education in their districts, and therefore included on the implementation team a network coach (NC) along with school district principals and administrators, university science educators and scientists, informal science educators, and industry partners. The NC, a full time employee of the project, will be a professional facilitator with expertise in working with people to "get things done." The NC will visit the teacher leaders throughout the AY to assist them with overcoming roadblocks, to accompany them on outreach activities (e.g., meeting with local businesses and government agencies to secure funding for needed materials/resources), and to review and assist the teacher leader in meeting deadlines for project implementation. The NC will focus on inspiring teacher leaders to enact change through PBS by providing ongoing support during challenging times. Due to circumstances beyond our control (e.g., the university's HR office taking too long to grant permission for us to hire), two candidates were offered the position and both declined our offer. Presently, the position has been readvertised, and it is our plan to employ the Network Coach at the beginning of the school year.

Preliminary work on the professional development schedule for the teacher leaders and district teachers began by meeting with administrators from both school districts to develop a schedule for continued professional development of the teacher leaders and professional development for district teachers. Teacher leaders will be released from their teaching duties two days a month as stated earlier for the following dates: September 14, September 28, October 12, October 26, November 9, November 30, and December 14. Robert Mendenhall (TPS) provided us with this schedule of released times for the fall that fits their district and will submit the request for the release of the teacher leaders. TCS teacher leaders will need to request their released times from each of their principals because the Diocesan schools are administered individually.

In the fall, the teacher leaders will work with their respective school leadership to develop a schedule for the professional development for the district teachers, which will begin in January 2011. The teacher leaders have requested to have the same schedule for both districts. Each month (January to May), teacher leaders will provide one professional development session with a follow-up visit to district teachers' classrooms. During the classroom visits, the teacher leaders will assist the district teachers in their implementation of PBS lessons. Janet Struble and the Network Coach will coordinate efforts among the groups.

*Determination of treatment and control schools***.** Working with both districts, Gale Mentzer determined the control and treatment schools through stratified random sampling. The list for the Toledo Public Schools may change because a large budget deficit resulted in two of the teacher leaders being laid off. We are waiting to see if the displaced teachers are rehired or assigned to a different school. At the very least, the displaced teachers will remain teacher leaders and become preferred substitute teachers in the district. The following list identifies the current schools involved in LEADERS Program:

Table 3.

Treatment and Control Toledo Public Schools

TPS Treatment Schools	**Control School Match**
Arlington Elementary School	Birmingham Elementary School
Bowsher High School	Waite High School
Burroughs Elementary School	Navarre Elementary School
Byrnedale Middle School	East Broadway Middle School

Crossgates Elementary School	Oakdale Elementary School
Hawkins Elementary School	King Elementary School
Keyser Elementary School	Rosa Parks Elementary School
Leverette Middle School	DeVeaux Middle School
McTigue Middle School	Robinson Middle School
Ottawa River Elementary School	Larchmont Elementary School
Riverside Elementary School	Longfellow Elementary School
Rogers High School	Scott High School
Sherman Elementary School	Whittier Elementary School
Toledo Technology Academy	Toledo Early College High School
Woodward High School	Start High School

Table 4.

Treatment and Control Toledo Catholic Schools

TCS Treatment Schools	Control School Match
St Francis de Sales High School	St. John' Jesuit High School
Cardinal Stritch High School	Central Catholic High School
St. Ursula High School	Notre Dame High School
St. Paul Elementary School (Norwalk)	St. Wendelin Elementary School (Fostoria)
Sylvania Franciscan Academy	Christ the King Elementary School
Queen of Apostles Elementary School	Our Lady of Perpetual Help
All Saints Elementary School	St. John Elementary School
Gesu Elementary School	St. Pius X Elementary School
St. Bernard Elementary School (New Washington)	St. Aloysius Elementary School (Bowling Green)
Kateri Catholic Academy	Lial Elementary School
St. Mary Elementary School (Shelby)	St. Francis Xavier Elementary School (Willard)

3) Transform existing K-12 science courses to rigorous and relevant science courses through PBS.

For Toledo Public Schools, our core partner, the current pedagogical and curricular practices, as is true in many school districts across the US, are been driven by the tests given to students, and students typically learn science by using textbooks. Toledo Public Schools is working to create a significant cultural change through professional development in key areas. Forty-one schools completed the second year of training for school-based teams to support professional learning communities based upon the work of Richard Dufour. In addition, Toledo Public Schools aligned all curricular adoptions to the Ohio Department of Education Standards and pacing guides were developed for all core academic subjects. The district implemented standards based report cards and quarterly summative assessments. The next step includes training in the use of formative assessments and providing interventions for students who are struggling with science. The Toledo Public Schools teacher leaders will continue the reform efforts started by their district by infusing science content on sustainable energy taught by using project-based science into their pacing guides. The LEADERS program is moving these efforts toward the Governor's goal of making "project based instruction commonplace in Ohio's schools." The teacher leaders in the

LEADERS program receive the professional support needed to continue the work of these current Toledo Public Schools efforts to implement PBS practices into the schools.

Designing Professional Development for Teachers of Science and Mathematics (2003) co-authored by Susan Loucks-Horsley, Nancy Love, Katherine Stiles, Susan Mundry, and Peter Hewson served as the framework in designing professional development for the teacher leaders in the LEADERS Program. Teacher leaders were engaged as adult learners as they learned content and science pedagogical knowledge needed to transform K-12 courses. During the summer institute, teachers participated in two science content courses, *Physical Principles of Energy Source* and *Chemical Aspects of Sustainable Energy.* This science content is needed to develop the curriculum based on sustainable energy. Scientists and science educators used the project-based science method to teach the content of the courses focused on driving questions. They planned their daily lessons using the 5 E Learning Cycle Model developed by Bybee and Landis (1988): (1) *Engagement* where instructors tap prior knowledge and spark interest in the concept/topics under study; (2) *Exploration* where participants develop and use inquiry skills through concrete, hands-on experiences; (3) *Explanation* that provides participants the opportunity to learn key scientific concepts; (4) *Elaboration* where the concepts are applied again, but in a new and contextualized way; and (5) *Evaluation,* which includes assessment opportunities along with the examination of related state achievement standards. The lesson plan for each day was housed in the folder on *Science Café* accessible to the teacher leaders. Science educators shared their thinking behind the plan, typically as a closure to the day's lesson. The teacher leaders learned about the 5 E Learning Cycle Model as they experienced learning the science content.

Ann Novak guided instruction in the development of PBS activities using *Teaching Science to Children: A Project-Based Science Approach* co-authored by Joe Krajcik and Charlene Czerniak. Ms. Novak modeled project-based science as the teacher leaders became students exploring the concept of energy. Ms. Novak provided examples of project-based science (PBS) teaching in her classrooms through verbal descriptions of classroom lessons, videos, and student artifacts. Ms. Novak facilitated class discussions about using PBS in teaching science from a teacher's perspective. Dr. Krajcik (an international researcher in project-based science) participated in videoconference call discussion with the teacher leaders. The teacher leaders developed PBS units linked to the Ohio's Science Standards, TPS pacing guides, and TCS Course of Study, which they will implement in their science classes in the fall.

Charlene M. Czerniak helped teachers developed their leadership skills and implemented poli-influential network in the course entitled *Science Leadership and Professional Development Design*. For the teacher leaders, the focus changed being a science teacher, an expert in one's classroom, to being a science leader, an expert in science teaching for school district. Teacher leaders explored the meaning of leadership and learned components of effective professional development. Teacher leaders applied this newly learned knowledge by developing and writing preliminary plans for district teacher professional development. Teacher leaders will continue their work on the professional development plans for district teachers in the fall.

In concert with these courses, informal science educators and local community colleges provided seminars that link the content to practical applications and community resources. The seminars provided the teacher leaders with the raw materials to develop PBS activities (part of the science curriculum) that bring relevance to the science classroom. As stated earlier, teacher leaders developed PBS units, which included information learned in the seminars.

During the school year 2010-2011, Czerniak, along with the Network Coach and LEADERS staff, are working with teachers two days a month for 10 months (20 days total) to implement a plan for testing the activities at identified grade levels, revise PBS activities, and disseminate them throughout the participating school districts. Teacher leaders will engage in lesson study as they implement their PBS unit. Lesson study is a structured process through which teachers a) plan a lesson, b) observe one teacher teaching the lesson, c) collect and analyze the evidence of student learning within the lesson, d) refine the lesson, and e) reteach the lesson, if necessary (Lewis, 2002). In a lesson study, teachers are focused on the teaching of one specific lesson and they work to improve that lesson. In LEADERS, each teacher leader will teach one lesson from their PBS unit; teacher leaders working in grade level groups will create a lesson study on the lessons being taught in the fall. Teacher leaders will use the Polycom videoconferencing system to view each other's teaching in real time. If this is not possible due to schedule conflicts, the Polycom system will record the lesson being taught and the video will be placed in the *Science Café*. Each teacher leader will bring in samples of student work, which will be analyzed by the other teacher leaders in the group in the next professional development session. Working within their grade-level group, teacher leaders will provide critical feedback on the effectiveness of the lesson in achieving the student learning goal (Loucks-Horsley, Love, Stiles, Mundry, Hewson, 2003) and offer suggestions for improvement. Teacher leaders will revise their lessons and upload them to the *Science Café* for others to give a final review.

Now that teacher leaders have experience teaching science through the project-based learning method, they will use their experiential experience to plan the professional development for the district teachers. The teacher leaders will revisit the professional development plans, which were created in the leadership course and critique it. The summer institute was an intense experience for the teacher leaders, attending class from 9:00 am to 5:00 pm for six weeks. The fall professional development will provide time for the reflection that is needed (Loucks-Horsley, et. al., 2003). Teacher leaders determined the science content their district teachers needed from Ohio's Science Standards, TPS pacing guides, and TCS Course of Study. The teacher leaders will model the PBS teaching method as the sustainable energy concepts are being taught to the district teachers. The teacher leaders will use the 5 E Learning Cycle Model to plan district professional development sessions as used in the TAPESTRIES (Toledo Area Partnership in Education: Support Teachers as Resources to Improve Area Elementary Science) program (Struble, Templin, Czerniak, 2008).

The district's professional development will be implemented spring semester 2011. Each grade level group will provide five professional development sessions (one per month till the end of the school year). Each teacher leader will coach several district teachers in follow-up visits to assist in implementation of the learning goal (PBS and content) of the professional development session. The professional development will continue online; teacher leaders will work to develop professional learning communities.

During the second summer institute, teacher leaders will continue with the leadership course to create science curricula focused on renewable energy, which will be tested and revise the second academic year. During the third Summer Institute, both Cohort 1 and 2 will attend the Summer Institute. This overlap will allow teacher leaders from all four districts the opportunity to meet and to develop relationships that can contribute toward future collaboration during the academic year. During fourth and fifth Summer Institutes, veteran teacher leaders from Cohort 1 will participate in the institute as mentors and instructors in the areas of leadership and PBS. They will have the opportunity to team teach with scientists. They will also provide assistance to Cohort 2 by sharing lessons learned, best practices, and overcoming challenges of achieving the project objectives.

4) ***Prepare K-12 students who can meet science and mathematics achievement standards and who become interested in science and technical careers.***

The section above described the details of the professional development for the district teachers, which will occur in the spring. The teacher leaders merged the science content from the summer institute (Physical Principles of Energy and Chemical Aspects of Sustainable Energy) with PBS pedagogy. The units also include the information and resources presented in the seminars. Teacher leaders will engage the community members to inform district teachers about sustainable energy careers relevant to the Great Lakes region. The spring professional development will provide the knowledge, tools, and community resources needed to implement PBS lessons into science classrooms.

The teacher leaders matched the science content of the PBS unit to the Ohio Science Standards. In our evaluation plan, Dr. Mentzer will be comparing the scores of the students on the Academic Yearly Progress on the Ohio Achievement Test (OAT) of the treatment and control schools. Student performance achievement will be linked to individual teachers attending the spring professional development.

The second institute will focus more specifically on achievement standards, testing and assessment, and teaching to the standards. Ohio is a new "Race to the Top" winning state, and we also expect this to impact some of Ohio's standards in the upcoming years.

5) ***Develop community science education networks that collaborate through the development and implementation of advanced or improved science courses.***

In this section, we describe our beginning efforts to establish community science education networks by describing the meetings with the scientists and science educators involved in Summer Institute 2010, the LEADERS website, and work associated with scientists and industry partners through the seminars and Advisory Board.

*Meetings with the Scientists and Science Educators***.** During the Summer Institute 2010, the two content courses were co-taught: Physical Principles of Energy Sources by Dr. Sanjay Khare of the Department of Physics and Astronomy paired with Dr. Mikell Lynne Hedley, science educator and Chemical Aspects of Sustainable Energy by Dr. Dean Giolando of the Department of Chemistry paired with Rolinda LeMay, science educator. The scientists, educators and their graduate assistants, along with Kevin Czajkowski and Janet Struble, met monthly starting in January. .Dr. Czajkowski described the transition of his own teaching style from lecture to more inquiry-based as a result of his experiences in the SATELLITES program (NASA) working with science educators, Janet Struble and Dr. Hedley. His description gave the other scientists a vision of the type of teaching needed in the summer courses and set the tone for future meetings. Dr. Czajkowski talked about the roles other scientists in national science partnerships. He asked science educators to share their knowledge of science pedagogy and provide examples to the group. Scientists and science educators updated each other on their thinking and planning of the summer courses.

*LEADERS Website***.** Gary Powell, technical support director, and Julianne Boyd, graduate assistant, took the lead in designing the LEADERS website (Figure 9). The website will be the "public" face of the program and will include materials developed in the courses that will be shared with district teachers in the professional development along with the general public. The website is continually being updated. The website includes the following components: "About Us" - information about our program and our partners; "News" – news-related publications and websites about LEADERS; "Resources" – content information and lesson plans for teachers to use; "Science Café" link; "Event Calendar" – list of dates and times of activities; and "Energy in the News" - up-to-date news regarding information on sustainable energy. The "Partners" page (Figure 10) lists the companies with hyperlinks to their websites.

Figure 9. Main Page of LEADERS Website

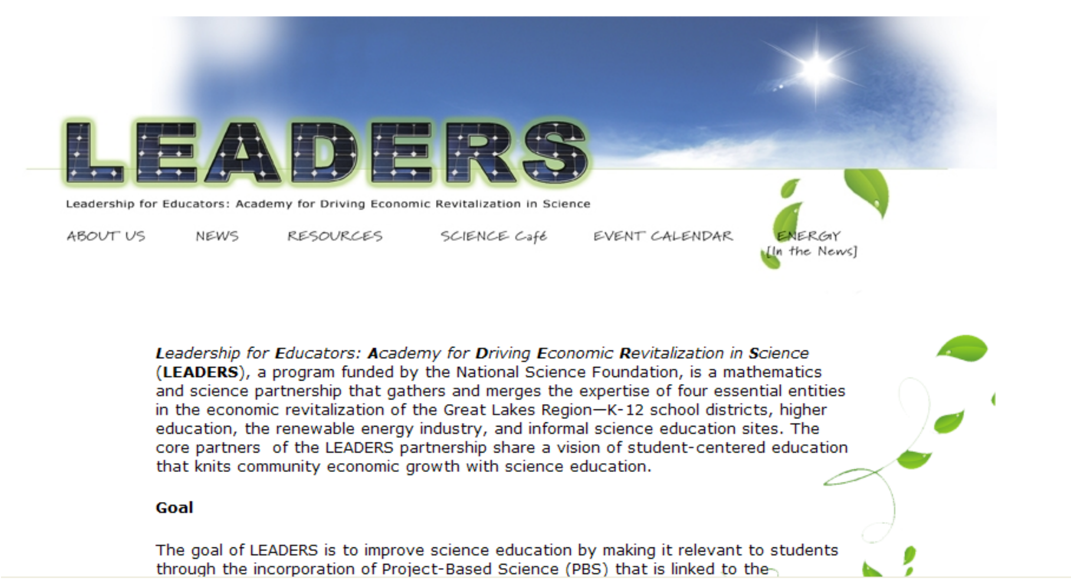


Figure 10. Community Partners Website

*Work associated with scientists and industry partners***.** In addition to serving on the Advisory Board (explained below), the corporate partners provide valuable insight into the emerging field of renewable energy through presentations on careers for the teachers and students. Our partners cover the topics of solar, wind and biofuels, geospatial technology and the impact of ethanol on the environment. Each corporate partner is supplying his/her own resources for this aspect of the project, and in doing so, each is engaging in community outreach. The teacher leaders are encouraged to partner with informal science institutions to assist with both the professional development activities they provide their districts and to develop a network of community resources all science teachers in their districts can utilize. These informal and corporate partners were brought in as presenters this summer, and we will continue to expand their roles in future summer institutes. Additionally, the Network Coach will also be expected to help guide these partnerships. One key component of PBS methodology is use of outside experts to answer real life problems. Thus, the design of the project inherently utilizes our informal and corporate partners.

Seminars: UT scientists and researchers, local business leaders, local college representatives, and area industry representatives participated in seminars that linked the science content to practical applications and community resources. The LEADERS program will build upon the relationships begun this summer with industry and community partners as we continue to develop the academic year programming and subsequent summer institutes.

Advisory Board: The Advisory Board, consisting of the CoPIs and community leaders, will be meeting this fall to review the evaluation data collected in the first year of the LEADERS Program and provide recommendations for continue project refinement, particularly with respect to community science networks.

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Major Findings

The Year 1 LEADERS project evaluation consisted of the collection of baseline data from the teacher leaders, the determination of whether teacher leaders gained content knowledge during the summer institute, and the collection of formative assessment data as to the general operation of the Summer Institute. The following is a summary of the findings; a more detailed evaluation report is in the Appendix.

The baseline data consisted of direct observation, the *Science Teacher Self-Efficacy Instrument (A),* and a project-developed *Leadership Responsibilities, Confidence, and Competency* survey. The data collected and compiled from these sources provided a rich picture of each teacher leader prior to participation in the LEADERS project. In general, the teacher leaders were adequate science teachers who used some investigative, inquiry-based instructional practices. While the majority had average to above average confidence in their ability to provide effective science instruction, they did not, as a group, feel that effective instruction alone could improve student science achievement. Prior to participation in LEADERS, none of the teachers held a great deal of the type of leadership responsibility that they will hold as a teacher leader although they were confident that they were up to the task. Some areas that they felt they needed more knowledge and skill in order to be effective teacher leaders included designing and presenting professional development linked to energy issues, understanding the needs of policy makers, understanding science education research, and knowledge of the needs of science teachers in their districts.

Comparisons of teacher leader pretest and posttest scores on renewable energy content covered during the Summer Institute, *Physical Principles of Energy Sources for Humans* and *Chemical Aspects of Sustainable Energy*, showed statistically significant gains for teacher leaders in both courses. Knowledge gains in *Project Based Science* will be assessed through examination of lessons developed by the teacher leaders during the academic year.

Feedback collected through a focus group interview at the conclusion of the Summer Institute revealed that the teacher leaders were happy with their summer experience but suggested an Institute schedule that facilitated more collaboration among the teacher leaders and balanced class time with appropriate field trips and guest speakers. Specifically, they hoped LEADERS senior project staff might consider more flexible or creative ways of offering the content courses in the summer (rather than three weeks every morning per class) so that time to work in groups or go on field trips can be integrated into the courses rather than stand-alone outside the courses.

The science education expert, Janice Koch, Ph.D., provided the evaluation team with suggestions for the coming year including exploring a means by which to specifically address participants' understanding of the ways to link science content to emerging local science–based industries in their grade-level science curriculums. Upon her recommendation, we will be adding this element to our Project Based Science Lesson rubric.

Opportunities for Training, Development, and Mentoring

The main purpose of the LEADERS program is training teachers. Since this is the main focus of this NSF grant, we described the training of the teachers in section 1 of "Activities and Findings."

The LEADERS Program provided three opportunities for training and mentoring of project staff: the staff retreat, meetings with scientists and science educators, mentoring of graduate assistants, and post doc mentoring of Dr. Brooks.

Staff Retreat. The staff retreat was designed to inform all parties working with LEADERS about the project as a whole and to set the stage to begin work on the summer institute. The project staff (scientists, educators, and industry leaders) met on March 5, 2010 at Hilton Garden Inn, Perrysburg, Ohio for a day long retreat. The LEADERS retreat helped ensure that all faculty (science and science education), school district administrators (Toledo Public Schools and Toledo Catholic Schools), community and business partners and staff interfacing with the K-12 schools had a clear understanding of the goals of the program and facilitated a collaborative relationship needed with the partners. The staff retreat provided time for teams of scientists and science educators to begin collaborating on the science content courses to be taught in the summer institute. Each attendee received a CD of all retreat presentations. The entire day was video-recorded and placed on the *Science Café*.

Retreat Agenda

March 5, 2010

I. Welcome – Charlene M. Czerniak
II. Why LEADERS? - Charlene M. Czerniak
III. LEADERS program - Charlene M. Czerniak
IV. Introductions – Kevin P. Czajkowski
V. Roles and Responsibilities - Kevin P. Czajkowski

VI. “Heating Things Up” Lesson– Kevin P. Czajkowski & Janet Struble
VII. 5 E Learning Cycle Model – Rolinda LeMay
VIII. Ohio Science Standards – Cherie Pilatowski
IX. Lunch
X. What is Project-Based Science (PBS)? – Ann Novak
XI. Technology – Gary Powell & Janet Struble
XII. Evaluation – Gale Mentzer
XIII. Break
XIV. Details of Summer Institute & Overview of the Academic Year I – Janet Struble & Kevin P. Czajkowski
XV. Next Steps - Kevin P. Czajkowski
XVI. Summer Planning Time with Scientist and Educator Pairs
Summer Planning Time with Business & Community Partners

Attendees

Name	**Position**	**Affiliation**
Dr. Abdollah A. Afjeh	Faculty	The University of Toledo
Dr. Milt Baker	Industry Partner	Blue Water Satellite
Ms. Julianne Boyd	Graduate Student	The University of Toledo
Dr. Lisa Brooks	Post-doc	The University of Toledo
Dr. Sorin Cioc	Faculty	The University of Toledo
Ms. Nancy Cochran	Graduate Student	The University of Toledo
Dr. Kevin Czajkowski	Faculty	The University of Toledo
Dr. Charlene M. Czerniak	Faculty	The University of Toledo
Ms. Nithya Doraiswamy	Graduate Student	The University of Toledo
Dr. Dean Giolando	Faculty	The University of Toledo
Ms. Martha Hartman	School Administrator	Toledo Catholic Schools
Ms. Laurie Hauser	Industry Partner	Toledo Imagination Station
Dr. Mikell Lynne Hedley	Science Educator	The University of Toledo
Dr. Sanjay Khare	Faculty	The University of Toledo
Ms. Janice Kusowski	Staff: Budget	The University of Toledo
Dr. Patrick Lawrence	Faculty	The University of Toledo
Ms. Rolinda LeMay	Science Educator	The University of Toledo
Dr. G. Glenn Lipscomb	Faculty	The University of Toledo
Mr. Disney Maxwell	Graduate Student	The University of Toledo
Mr. Robert Mendenhall	School Administrator	Toledo Public Schools
Dr. Gale Mentzer	Staff: Evaluation	The University of Toledo
Ms. Ann Novak	Science Educator	Greenhills School
Ms. Cherie Pilatowski	School Administrator	Toledo Public Schools
Mr. Gary Powell	Staff: Technology	The University of Toledo
Mr. Norman J. Stevens	Industry Partner	Advanced Distributed Generation LLC
Dr. Donald J. Stierman	Faculty	The University of Toledo
Ms. Lacey Strickler	Graduate Student	The University of Toledo
Ms. Janet Struble	Staff: Project Coordinator	The University of Toledo
Dr. Ed Weston	Industry Partner	Great Lakes WIND Network

Meetings with the scientists and science educators. During the Summer Institute 2010, the two content courses were co-taught: Physical Principles of Energy Sources by Dr. Sanjay Khare of the Department of Physics and Astronomy paired with Dr. Mikell Lynne Hedley, science educator, and

Chemical Aspects of Sustainable Energy by Dr. Dean Giolando of the Department of Chemistry paired with Rolinda LeMay, science educator. The scientists, educators and graduate assistants, along with Kevin Czajkowski and Janet Struble, met monthly beginning in January. Dr. Czajkowski described the transition of his own teaching style from lecture to more inquiry-based as a result of his experiences in the SATELLITES program (NASA) working with science educators, Janet Struble and Dr. Hedley. His description gave the other scientists a vision of the type of teaching needed in the summer courses and set the tone for future meetings. Dr. Czajkowski talked about the roles of other scientists in national science partnerships. He asked science educators to share their knowledge of science pedagogy and provide examples to the group. Scientists and science educators updated the group on their thinking and planning of the summer courses.

Logistics were also discussed regarding facilities, equipment, technology needs, and Internet for the summer courses. The science content courses were taught in the science education laboratory; not in the labs of the scientists because of the technology the room provided (SmartBoard, videoconferencing, etc.). The college of education has wireless Internet connection, which was needed for the teacher leaders to work in the *Science Café.*

The science educators met with Janet Struble monthly to discuss and identify renewable energy education resources, give input on the design of the *Science Café*, and receive training in the use of the SmartBoard technologies. Even though the scientists were expected to plan their courses spring semester, they waited until about three weeks before their courses were to take place to plan the topics being addressed for each day. This late planning impacted the science educators by forcing them to plan lessons and loading items into the *Science Café* at the last minute, many on the day the lesson occurred.

Mentoring of graduate assistants and science education coordinator. The graduate assistants, Lacey Strickler, who started in the fall and Nithya Doraiswamy, who started in the spring, met weekly with Dr. Charlene M. Czerniak to research and develop the leadership class. Additionally, initial discussions about research related to the project occurred.

In planning the leadership course, Dr. Czerniak served as a mentor to the graduate assistants. She modeled the thinking process involved in the planning of a graduate level course. She guided them in determining the topics needed for the course. Each picked a topic of interest to research and developed lessons to teach to the teacher leaders. The graduate assistants presented the lessons to the planning group, received feedback, and revised their lessons. Dr. Czerniak coached the graduate assistants as they taught their lessons to the teacher leaders in the summer institute. For two of the graduate assistants, Lacey Strickler and Nithya Doraiswamy, Dr. Czerniak's mentorship included support in teaching a lesson as neither of the students had teaching experience.

Dawn Wallin, hired as Science Education Coordinator in the fall, was also mentored by Czerniak about professional development design and teacher leadership. During the spring, PI Czerniak provided Dawn Wallin funds from indirect overhead monies to attend the National Science Teachers Association Conference in Philadelphia, and she provided Lacey Strickler with funding to attend the annual conference of the National Association for Research in Science Teaching (NARST). Attendance at both of these conferences helped in mentoring these individuals.

Post doc mentoring of Dr. Lisa Brooks. The post doctoral assistant, Lisa Brooks, PhD, was hired in January 2010. She was selected because of her strong background in mixed methods research design, her practical experience in project-based science, and her PhD in science teacher education. She is supervised by the project evaluator, Dr. Gale Mentzer. Lisa has been charged with researching appropriate means by which to measure project outcomes—particularly the implementation of project-based science, leadership, partnerships with industry, and the degree to which renewable energy is incorporated into the lessons. The majority of her time has been spent reviewing applicable literature and locating or designing instruments to measure these constructs.

During the spring, PI Czerniak provided Lisa with professional development funds (funding outside of the LEADERS grant) to allow her to attend the annual conference of the National Association for Research in Science Teaching (NARST). She submitted a proposal to the 2011 NARST conference based upon her work with LEADERS in the area of assessing the project's impact on teacher leaders' understanding of project-based science. Both Czerniak and Mentzer have provided her with guidance on this proposal.

Lisa has been actively involved in the development of the Science Café—an online forum that includes a place for the evaluation team to gather needed data from the teacher leaders. She worked closely with the Project Coordinator (Struble) and technical support director (Powell) to create an evaluation section that would be easy for teacher leaders to access.

Lisa also conducted personal interviews with each of the teacher leaders to establish qualitative baseline data specifically concerning attitudes about leadership and effective science instruction. Lisa is interested in conducting research on project-based science and is currently working on a detailed research design to be approved by Mentzer (for research design validity) and Czerniak (for project-based science validity). Because Lisa's career goals include working at a university in science education, we are exploring opportunities for her to gain undergraduate and graduate teaching experience in project-based science methods (outside of the LEADERS project).

Finally, Lisa mentored the two science education graduate assistants in the areas of conducting literature reviews, and developing research designs. Her work with the graduate students has been valuable to the students and has allowed her to develop leadership and mentoring skills of her own.

Outreach Activities

The LEADERS program contained two outreach activities this past year: the Press Event at Imagination Station and the seminars in the summer institute.

Press Event. The LEADERS Press Event took place on Wednesday, June 9 at 10:30 am at the Imagination Station in Toledo, Ohio. The teacher leaders, principals, and administrators from Toledo Public and Toledo Catholic Schools, as well as The University of Toledo's scientists and educators involved in the LEADERS summer institutes, were introduced to the public. WTOL-Channel 11 TV Station in Toledo and The Toledo Blade (Toledo's daily newspaper) were present to cover the event. The agenda is listed below:

Press Event Agenda

I. Welcome – Lori Hauser from Imagination Station
II. Dr. William McMillen – UT Interim Provost
III. John Foley – TPS Superintendent
IV. Carolyn Jaksetic – Assistant superintendent of Toledo Catholic Schools
V. Charlene M. Czerniak – Co-Principal Investigator
VI. Kevin Czajkowski – Co-Principal Investigator
VII. Dr. Tom Brady – Interim Dean of the Judith Herb College of Education

After the event, the teacher leaders received an orientation to the Summer Institute 2010 that was to begin the following week. Each teacher leader received a Dell laptop with an external CD drive. Laptops were purchased through department funds at the University of Toledo. At the end of the orientation, teachers completed pre-assessment surveys for the program.

The orientation agenda is listed below:

Teacher Leaders Orientation

I. Welcome – Charlene M. Czerniak
II. Logistics – Janet Struble
III. Concept Mapping – Kevin Czajkowski

i. First assignment – each teacher will bring to class on Monday a concept map on "energy."

IV. Evaluation – Gale Mentzer
V. Working with your laptop – Maria Vasquez
VI. Science Café – Gary Powell

Seminars. In concert with the courses described above, UT scientists and researchers, local business leaders, local college leaders, and area industry representatives were solicited to participate in seminars that linked the science content to practical applications and community resources that gave the teacher leaders information to bring relevance to their science. The school partners, along with LEADERS PIs, brainstormed a potential list of speakers and UT facility or business tours at meetings in April and May. The overall driving question for the two weeks was "How will you prepare your district's students for tomorrow's jobs?" with the driving question for each day "How will you apply the knowledge that you learned from today's seminar in your classroom and the professional development you will design for your district?" These questions were stated at the beginning of the afternoon sessions. The seminars were focused around a theme (in bold in the seminar schedule). Each presenter was asked to provide a short biography with contact information and to address the following questions in his/her presentation:

1. What does your department/company do/produce and how is your service/product related to renewable energy?
2. How does your company fit into the economy of NW Ohio and contribute to the economic revitalization of the community?
3. What knowledge and skills do the students of these teachers need in order to work at your company?

The teacher leaders were required to reflect on each day's presentation(s) in an electronic journal (on *Science Café*) by answering the following questions: "How will I apply what I learned today?" (The "how" should include the "what" – the information and/or skills) and "What elements of PBS help prepare students for jobs in their future?" Teachers were given time to do this at the end of the afternoon session.

The first seminar session "Preparing Today's Students for Tomorrow's Jobs" reiterated the goal and outcomes of the LEADERS Program, explained how the seminars addressed them, and set the stage for the next two weeks. The seminar schedule is listed in Table 5. Each afternoon session began with an engagement, setting the stage for the presentations and ended with closure, synthesizing the information and translating to K-12 student learning. On Friday, July 2, Rick Mangini from the Ohio Department of Education spoke to the teacher leaders via video-conferencing from Columbus. He provided an overview of Ohio's efforts to prepare students with 21st Century Skills. Through an active dialogue, teacher leaders had a better understanding of what will be expected of teachers in the future and how project-based science curriculum fits into the development of the 21st Century Skills. After the presentation, the teacher leaders were given the task of creating video podcasts to inform their districts of 21st Century Skills. Storyboards were developed, critiqued and revised. Teacher leaders will be using their students in their schools to produce the podcasts in the fall. On Thursday, July 8, wrap-up and closure for the seminars was conducted after Mr. Richardson's presentation. Teacher leaders were asked to identify a seminar presentation and share with others in the class their reflection for that presentation, which was posted in their electronic journal.

Table 5 lists the seminar speakers with titles, affiliations, and presentation titles.

Table 5.

Seminar Schedule

Monday, June 28	**Preparing Today's Students for Tomorrow's Jobs**
Mary Jo Waldock	The Importance of Innovation & Science Education to the Future of our

UT Innovation Enterprises *Joseph Peschel* Owens Community College Coordinator of Customized Training	Economy and Region Owens Community College Solar Installer Program & Other Training Opportunities in Renewable Energies
Tuesday, June 29 *Milt Baker* CEO *Gale Tedhams* Director of Sustainable Communities & Green Products– Owens Corning	**LEADERS Business Partners and their Roles** Blue Water Satellite, Inc. Winning with Green Tour of Owens Corning International Headquarters
Wednesday, June 30 *Tim Mayle* Hardin County GIS Coordinator *Thomas Brady* Dean of Judith Herb College of Education *Kenneth Kilbert* UT Associate Professor of Law	**Sustainable Energy in Action** Applying GIS in Wind Energy Development Preparing 21st Century Teachers Climate Change and the Law
Thursday, July 1 *Amanda Gamby* Environmental Educator *Chris Downey* Sales Manager Stark's Inc.	**Sustainable Energy in Action Tours** Tour of Bowling Green Wind Farm Green by Design: Presentation on Green Construction Materials Company Overview & Showroom Tour
Friday, July 2 Richard Mangini Ohio Dept of Education Career & Technical Education	**Preparing Students for 21st Century Skills: A State's Perspective** Preparing Today's Students for the Jobs of Tommorrow: What Ohio Businesses Want
Tuesday, July 6 *Megan Reichert-Kral* Director Clean Energy Incubator *Chuck Lehnert* Vice President UT Facilities & Construction	**Incorporating Sustainable Energy on UT campus and in NW Ohio** Clean Energy Incubator Tour of Clean Energy Incubator UT *Green* Facilities: Applying the Research Tour of Scott Park Campus
Wednesday, July 7 *Steve Weathers* President & CEO Regional Partnership Growth & Rocket Adventures *Neil Reid* Director UT Urban Affairs	**The Many Facets of Economic Development** The Role of Sustainable Energy in the Revitalization of Northwest Ohio Perspectives on Economic Development in Northwest Ohio

Thursday, July 8	**NW Ohio Projects & Student Projects relating to Sustainable Energy**
Alan Bowen Project Manager Advanced Distributed Generation LLC	Solar Project for the Green Belt Parkway
Ted Richardson Teacher Toledo Technology Academy	Renewable Energy Projects for Students
Friday, July 9	**LEADERS Evaluation, Your Research, and Your Concerns**
Gale Mentzer *Lisa Brooks* LEADERS Evaluators	LEADERS Evaluation regarding district teachers
Kevin Czajkowski	Brief Overview of Thesis requirements
Elaine Reeves *Mark Horan* *Daniel Feinberg* UT Libraries-Carlson Library	Using UT Resources in your Research
Kevin Czajkowski *Charlene M. Czerniak*	Miscellaneous Concerns

Publications and Products

This section describes the publicity the LEADERS Program received and the materials created to promote our program.

Publications about the LEADERS Program to the General Public

The University of Toledo's Communications Office helped us in promoting the LEADERS Program to the general public. The following summarizes the publicity we received.

***Media*.**

WGTE TV Station *Plugged In*. Educational Alternatives: Developing "green" curriculum for classrooms. http://www.wgte.org/wgte/watch/item.asp?item_id=4811

WJR Radio Station. (September 24, 2009). *Environmentally Sound*. Dr. Kevin P. Czajkowski and Dr. Charlene M. Czerniak were interviewed by Larry Burns. http://www.leaders.utoledo.edu/media/ES_9_22_09.mp3

WGTV TV Station. (September 17, 2009). Energy Education Comes to Toledo Schools. http://abclocal.go.com/wtvg/video?id=7029627

***Print*.**

The Toledo Blade. (June 14, 2010). Alternative energy is focus of UT program; educators to build new curriculum. http://toledoblade.com/article/20100614/NEWS04/6140306

UT News. (June 7, 2010). First class of teacher leaders to be announced. http://utnews.utoledo.edu/index.php/06_07_2010/first-class-of-teacher-leaders-to-be-announced

Independent Collegian (September 21, 2009). Grant seeks to stimulate regional economy. http://www.independentcollegian.com/news/grant-seeks-to-stimulate-regional-economy-1.1905863

The Toledo Blade. (September 17, 2009). Teachers to hone science skills: UT to link alternative energy curriculum, K-12 educators. http://www.toledoblade.com/apps/pbcs.dll/article?AID=/20090917/NEWS04/909170307

UT News (September 17, 2009). $5 million grant links science education to economic development. http://utnews.utoledo.edu/index.php/09_17_2009/5-million-grant-links-science-education-to-economic-development

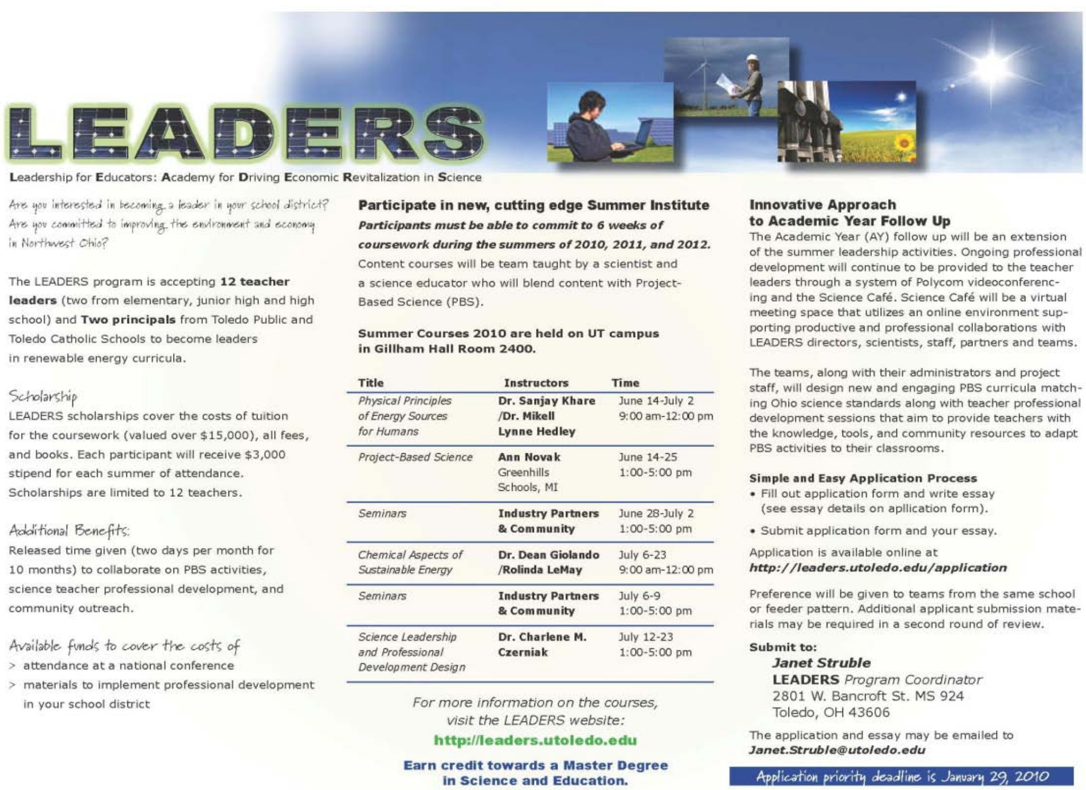
Products developed for the LEADERS Program

The following section provides examples of the teacher recruitment materials and materials developed for the staff retreat.

Teacher Recruitment. Teacher recruitment webpage, brochure, application, and flyers to school districts appear below. The recruitment PowerPoint presentation can be viewed at the following website: www.leaders.utoledo.edu/teacher_leader_program.aspx

Figure 11. Teacher Application Webpage

Figure 12. LEADERS Brochure



Fi

Figure 13. LEADERS Teacher Application

LEADERS

Leadership for **E**ducators: **A**cademy for **D**riving **E**conomic **R**evitalization in **S**cience

Preliminary Application

Are you an energetic and passionate individual interested in integrating renewable energy concepts into the curriculum, developing tomorrow's leaders, and helping to improve the economy in Northwest Ohio?

12 teacher leaders (***two each*** from elementary, junior high and high school) and **TWO** principals will be selected to participate in the program from Toledo Public Schools and Toledo Catholic Schools. We are looking for individuals interested in taking on leadership responsibilities in their schools and who have strong science backgrounds and/or interest to create, test, refine and disseminate science curricula focused on renewable energy and to plan and implement district-wide projects.

1. Please fill in the following information and submit it with your application materials.

Name: ______________________________

Current License and Grade Levels: ______________________________

Subjects Currently Teaching: ______________________________

Grade Level: ______________________________

Are you currently enrolled in The University of Toledo's Graduate Studies? ☐ Yes ☐ No

School: ______________________________

School Phone: ______________________________

Home Address: ______________________________

Home or Cell Phone: ______________________________

Email Address (that you check regularly): ______________________________

☐ A colleague in my school or within the same feeder is also interested in joining the LEADERS program.

Colleague's name and contact information: ______________________________

☐ My principal is interested in joining the LEADERS program.

Principal Name: ______________________________

LEADERS *APPLICATION* *1*

2. Submit an essay (no more than 5 pages typed, double spaced and use 10 or 12 point font) stating why you want to be in the LEADERS program. It is suggested that you include supporting evidence of previous leadership roles in the district, state or national recognition and/or awards as a teacher, participation in other teacher leadership projects, strong science background and/or interest in science, respect among peers, experience with adult learners, and commitment to the National Science Education Standards.

Submit to:

Janet Struble

LEADERS *Program Coordinator*

2801 W. Bancroft St. MS 924

Toledo, OH 43606

The application and essay may be emailed to ***Janet.Struble@utoledo.edu***

Priority deadline submission date – January 29, 2010

NOTE: *This is the preliminary application process. The full application* ***may*** *include, but not be limited to, the following:*

1) Science Teaching

- ☐ Observation of your science teaching.
- ☐ Provide a summary of your lesson plan and a reflective essay critiquing the lesson.
- ☐ Write an essay telling us your philosophy of teaching science.
- ☐ Submit a letter of recommendation from colleague or parent to support the evidence (listed above).

2) Leadership

- ☐ Describe the leadership roles you have played in general and in the fields of science and/or science teaching.
- ☐ Submit a letter of recommendation from a principal or administrator providing evidence of your leadership capabilities.

3) Academic rigor

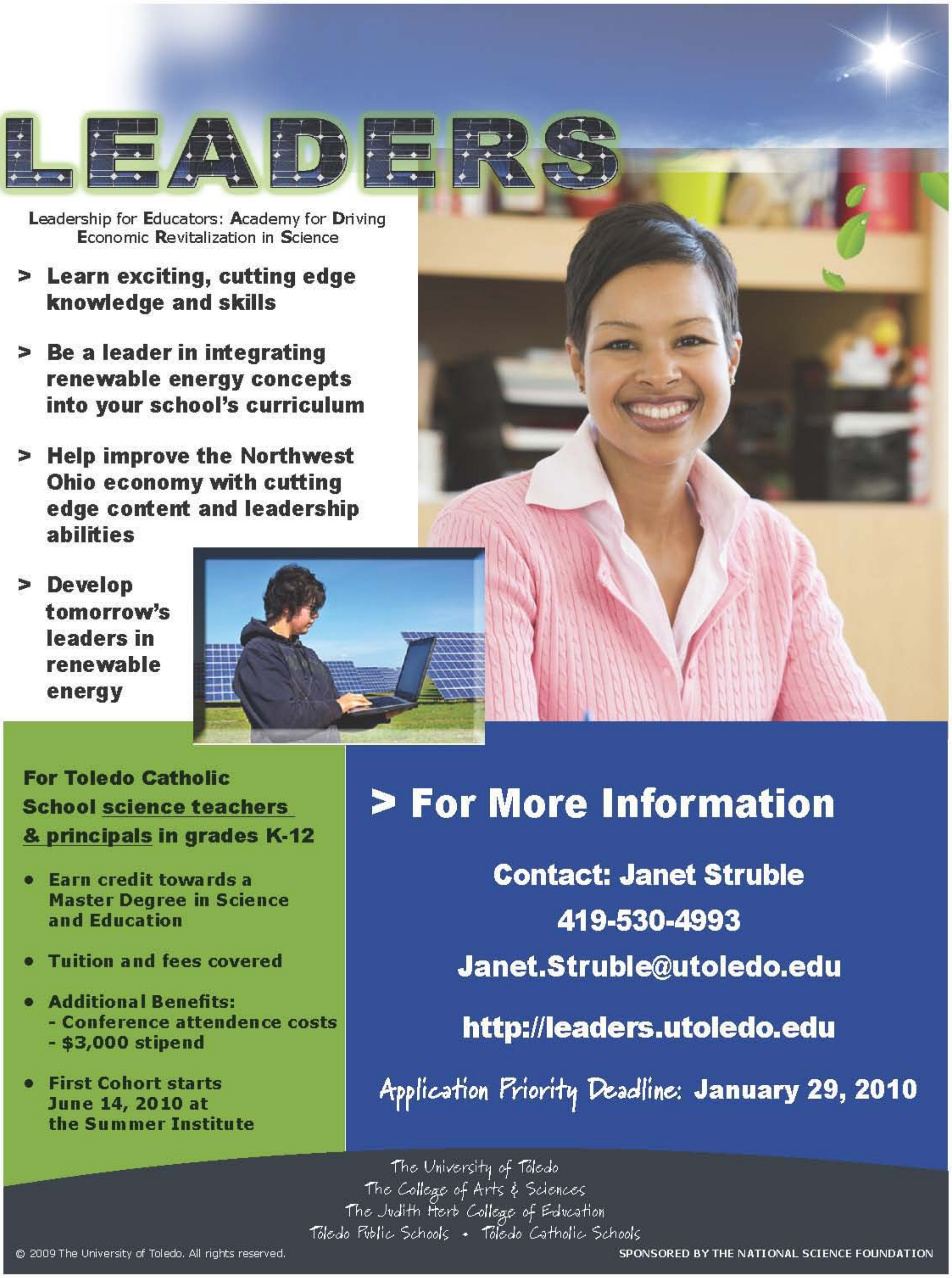
- ☐ Describe your graduate level academic background and why you want to further your knowledge of renewable energy.
- ☐ Submit a letter of recommendation from a professor or person you have taken a class from providing evidence of your graduate level academic abilities.

If you have any questions about LEADERS, call Janet Struble at 419-530-4993.

LEADERS website: ***http://leaders.utoledo.edu***

Figure 14. LEADERS Flyer Announcement of Meeting for Toledo Public Schools

Figure 15. LEADERS Flyer General Announcement for Toledo Catholic Schools



LEADERS Retreat. A CD was produced of all the PowerPoint presentations featured at the retreat and given to attendees and non-attendees. The contents of the CD are on our website: www.leaders.utoledo.edu/leaders_retreat.aspx. The following is a list of the contents:

1. Agenda
2. Directory
3. Presentations with related documents
    a. Overall Program
    b. Team Members
    c. Roles and Responsibilities
    d. *Heating Things Up* Lesson: An Example of Inquiry-Based Lesson
        i. Surface Temperature Fact Sheet
        ii. Data Table
        iii. Noting What I have Learned Graphic Organizer
        iv. Lesson
    e. 5 E Learning Cycle Model
        i. InfoSheet
    f. Ohio Science Standards for Energy
    g. Project-Based Learning
        i. Brockman-Canaan Video Clip
        ii. Obama Energy Audio Clip
    h. Technology
    i. Evaluation
    j. Summer Institute and Academic Year Planning

Contributions

The Principal Discipline of the project

The principal discipline of the LEADERS project is renewable energy. By definition, this is a very interdisciplinary subject spanning geography, physics, chemistry, environmental science and several types of engineering. In the first year, we focused on the physics and chemistry of renewable energy. The unifying theme was energy.

Other Disciplines of Science and Engineering

As an interdisciplinary project, LEADERS included physics and chemistry this first year. However, we also focused on the economics of the peak of a resource such as oil and coal.

Development of Human Resources

Contributions to the development of human resources have been described throughout this report in previous sections. We will not repeat those here. We have made an impact on graduate students, which has not been previously reported. Two of the science graduate students, Nancy Cochran and Disney Maxwell, were exposed to teaching techniques including the 5 E model, jigsaw, pair-share, etc. for the first time. Paul Nolan, who is a graduate student pursuing his teaching licensure through an alternative licensure program gained valuable experience through his interaction with the teachers.

Physical, Institutional or Information Resources that form the Infrastructure for Research and Education

LEADERS Website and *Science Café.* The following section discusses the process of designing, planning, and creating the LEADERS Website and the *Science Café*.

LEADERS website. Gary Powell, technical support director, and Julianne Boyd, graduate assistant with a background in graphic design, took the lead in designing the appearance and layout of the LEADERS website (Figure 16 and Figure 17). The work on our website began immediately after the notice of the grant award. Gary Powell and Julianne Boyd researched websites pertaining to energy; Charlene M. Czerniak also provided some websites to view. Julianne Boyd proposed three different designs to the website for Kevin Czajkowski and Charlene M. Czerniak. Once the appearance was determined, Julianne Boyd designed supporting pieces for the program such as formatted Word documents, flyers, banner, PowerPoint templates, and CD labels.

After the graphic design of the website was decided upon, Janet Struble met Gary Powell and Julianne Boyd every two weeks to discuss the creation of web pages and the information needed to portray the LEADERS Program to the online community. The design of the website employed many User Interface design features used on the Internet today. The LEADERS website's User Interface is a simple, clean design employing clean text and graphics to facilitate ease of use by the public. The website is the public face of the LEADERS grant and its partners to increase the public's understanding of renewable energy.

User Interface Features

- Light back grounds with dark text
- Clean fonts
- Clean graphics
- Minimalist design
- Wide margins and spacing
- Easy to read
- Easy navigation
- No more than 3 clicks

The User Experience of both the LEADERS website and *Science Café* (discussed later) employ a similar design language to unite the two sites with a consistent look and feel. The site needed to be easy to read, easy to use, and easy to follow by all users. The primary purpose is to provide information regarding renewable energy and should be looked upon as an informational resource of energy topics.

User Experience Features

- Simple to navigate
- Easy to read
- Collaborative
- Customizable

*Figure 16.*Main Page of the LEADERS website

Figure 17. Supporting Partners website

Science Café. To facilitate communication and social networking among teacher leaders (between and within school districts), project staff, and supporting partners, an innovative element of LEADERS was developed and called *Science Café*. As stated in the grant, The *Science Café* is a virtual meeting space that utilizes an online environment supporting productive and professional collaborations and needs to contain all the online elements (such as the tools used in Blackboard and WebCT) for the courses offered in the summer institutes.

When given this task to develop *Science Café*, Janet Struble, project coordinator, Gary Powell, technical support director, and Julianne Boyd, graduate student in educational technologies, (later will be referred to as the designers), combed the research related to professional learning communities, online virtual communities, face-to-face and online teacher professional development, and instructional design of online learning communities.

In examining the definitions of community, face-to-face or online, the foundation for the meaning of a community begins with Lave and Wenger (1991) who coined the term “communities of practice.” “Communities of practice” is a group of people, linked by a common interest, who share information and experiences within the group. As a result, the members learn from each other and develop personally and professionally. Extending the communities of practice to an online or virtual community, Owston (1998) added that the information and the sharing of the group are being done in an online environment. Preece (2000) defines the online community as a) a group of people who interact socially to meet their own needs with each individual performing a special role; b) a shared purpose which motivates the group; c) guidelines for the group’s interactions; and d) computer systems, which support and facilitate the group’s interactions.

The *Science Café* encompasses several groups with individuals playing different roles depending on the group they are in. Some of the groups include PIs, staff, scientists, science educators, graduate assistants, business partners, school administrators, and teacher leaders. For example, the science leadership class was planned within the *Science Café* by a team of people (PI Czerniak, a former principal, a former informal educator, graduate assistants, and Janet Struble) sharing their expertise and collaborating in the designing of the lessons. This group assumed a different role, role as instructor, in the section of the leadership class created for the teacher leaders. A person’s role can change depending on the group.

When designing the *Science Café*, the designers envisioned professional development in a broad sense when deciding on the features needed to accommodate the needs of all parties, and at the same time use the research conducted in face-to-face teacher professional development as a guide. In designing teacher professional development for the online environment, the designers of the professional development need to change their current perceptions of professional development (Lock, 2006). The LEADERS program’s main reference regarding professional development was the book entitled *Designing Professional Development for Teachers of Science and Mathematics*, co-authored by Susan Loucks-Horsley, Nancy Love, Katherine Stiles, Susan Mundry, and Peter Hewson (2003). Creating, building, and supporting an online learning of a professional development community is a process that has a purpose and fluidity in nature, which meets the needs of the people involved; technology is not an add-on to the professional development (Lock, 2006).

Once the designers established guideposts regarding what needed to be done with professional development, the ADDIE Instructional Design Model was used in designing the *Science Café*. The ADDIE model supports a collaborative, learner-centered environment with activities designed around the learning outcomes. The ADDIE model is used in the designing of courses for online delivery; it is considered a *project management tool (http://raleighway.com/addie/).* Since a major part of *Science Café* houses the delivery of course content, the designers found that the ADDIE model was useful in designing it as a whole.

ADDIE is an acronym for the following stages: **Analysis, Design, Development, Implementation, and Evaluation**. Each stage poses specific questions; these questions guided the development of the online learning development. The **Analysis** stage deals with pre-planning: determining the design, developing a timeline, identifying your audience, stating your purpose, defining the knowledge and skills being learned, and foreseeing barriers. The design of the *Science Café* needed to be simplistic, easy to use, and have a consistency of the appearance translated into each section. The timeline included the general time frame: a) first meeting took place on October 16, 2009, b) completion of a trial version by February, c) training for users on a group by group basis, d) revisions were made as needed, and e) final version ready for summer institute in May. The audiences change depending on the location within the *Science Café*. The skills of the audience range from technically savvy (PIs and staff) to novice (e.g., teacher leaders not able to attach documents to emails). The purpose of the *Science Cafe* is to create an online environment in which all parties can function socially in order to share knowledge/expertise and to grow as individuals as well as a group. The renewable energy, economy of the Great Lakes, and PBS foci of LEADERS determined the content knowledge needed in the *Science Café*: a) science content on renewable energy and any necessary background information to understand the science content, b) science education pedagogy including project-based science and how students learn science, c) industry including translation of research into business and applications in northwest Ohio, and d) the skills today's students will need in the future. The barriers included issues dealing with technology failures or having a variety of computer systems accessing the site.

The **Design** stage focuses the process of the learning taking place: identifying course content, writing the learning objectives, deciding on instructional strategies, determining media, online resources and tools to use, and writing the lessons. In the **Design** stage for *Science Café*, the designers concentrated on designing a space for the lessons, media, and resources and determining the tools that group as a whole may need to use. This includes tools the scientists and science educators may want to use to facilitate learning. The learning that takes place within the *Café* occurs on two levels: on an individual basis focusing on course content and learning as a collaborative community. To play on the idea of a *Café*, a different colored coffee cup corresponding with the color scheme of the location along with a banner appears on the main page of every section. Next, the designers needed to determine the online delivery system that would be used.

When considering the delivery system to house the *Science Café*, a matrix listed at the State Educational Technology Directors Association website in the NLI Toolkit 2005 served as a guide in determining the tools needed in the *Science Café*. At the 2004 National Leadership Institute (NLI), SETDA leaders focused on the topic of "virtual learning." The leaders examined, discussed and developed a toolkit "designed to help education leaders effectively use virtual learning to increase opportunities through technology that will help students learn and teachers teach" (http://www.setda.org/toolkit/toolkit2004/).

The designers explored over 30 web-based application programs that included many of the tools listed above and decided to use Microsoft's *SharePoint.* Selecting Microsoft *SharePoint* was key to a consistent User Experience for all members of the *Science Café*, with ease of use and compatibility with several version Microsoft tools used on campus including Outlook and the Office suite. The LEADERS PIs and staff used a trial version of *SharePoint* for four months to determine its functionality and ease of use before making the final decision to adopt it. Coincidently, The University of Toledo was considering purchasing and using *SharePoint* and ultimately did so after we reported our success with it. The *Science Café* is now housed on the university's server.

In the **Development** phase, the course materials are developed and assembled according to the plan created in the Design phase. With Gary Powell taking the lead, the designers first developed the appearance and the components of the *Science Café.* Janet Struble, participant in several online courses as a student or a facilitator/ instructor, and Julianne Boyd, graduate student in educational technologies, determined the components needed to create a user-friendly environment for learning.

The design of the *Science Café* took advantage of many User Interface design features employed on the internet today: consistent look and feel of the different sections of the *Science Café* and the placement of buttons and menu items in a logical manner. The User Interface of the *Café* has a consistent layout but uses color to differentiate the various sections of the *Café*. The User Interface is also customizable by both the Administrator as well as the *Café* members. Members can customize their personal view of the *Café* interface; arrange the placement of *Café* parts for example (lists, calendars, and announcements) and minimize components to simplify their view. The User Experience of the *Science Café* employs a similar design language of the LEADERS website to unite the two sites with a consistent look and feel. The website experience was characterized by all users as easy to read, easy to use, and easy to follow. After the trial site was up and running, the designers asked for input from all parties (including professors and educators teaching the content) at meetings or via email. In a meeting on April 21, 2010, the science educators commented on the overall structure of the *Science Café* and worked with the designers to determine the creation of certain folders, their names, content, and location within the *Café*. The lessons created for the content courses followed the 5 E Learning Cycle Model (determined in the grant proposal) and the 5 E Learning Model Lesson template (Figure 18) was updated from a previous NSF funded project (TAPESTRIES) and used for LEADERS.

Figure 18. 5 E Learning Model Lesson Template

Leadership for Educators: Academy for Driving Economic Revitalization in Science

LEADERS 5-E Planning Guide
Teacher - Teaching Side

Topic ________________________ **Lesson:** ________ **Date:** ________

Overall Driving Question:

Driving Question for this lesson:

Ohio Grade Level Indicator(s):

Concepts:
- ____________
- ____________
- ____________

"5-E" Phase	Planned Activities/Events	Guiding Questions	Notes: Materials, Safety, Graphic Organizers
Engage ☐ Tap prior knowledge ☐ Focus learners' thinking ☐ Spark interest in the topic			
Explore ~ HANDS-ON! ☐ Provide learners with common, concrete, tactile experiences with skills and concepts ☐ Observe and listen to students ☐ Ask probing questions ☐ Act as a consultant			
Explain ~ MINDS-ON! ☐ Encourage students to explain concepts in their own words ☐ Ask for justification ☐ Use students' previous experiences as the basis for explaining concepts ☐ Clarify and correct misconceptions			
Extend ~ HANDS-ON! ☐ Apply same concepts and skills in anew context resulting in deeper and broader understanding ☐ Encourage the students to apply the concepts/skills to new situations via new activities			
Evaluate ☐ Observe the students as they apply new concepts and skills ☐ Assess, formally and/or informally, student progress toward achieving the learner outcomes (knowledge and/or skills) ☐ Allow students to assess their own learning and group-process skills			

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Leadership for Educators: Academy for Driving Economic Revitalization in Science

LEADERS 5-E Planning Guide
Student - Learning Side

Learner Outcomes/ Evidence of Learning: What will the students be able to do or know as a result of this experience (use measurable action verbs).
The Students will…
1.
2.

"5-E" Phase Student Performance Indicators	Describe the Learning Environment (what are the students doing)	Possible Questions your Students May Ask	Classroom Management Tips
Engage ☐ Shows Interest ☐ Asks questions			
Explore ☐ Formulates questions ☐ Tests hypotheses ☐ Records observations and data ☐ Draws reasonable conclusions ☐ Proposes explanations			
Explain ☐ Uses recorded observations in explanations ☐ Explains possible solutions ☐ Listens critically to others' findings ☐ Questions one another's explanations ☐ Listens and tries to comprehend the explanations that the teacher offers			
Extend ☐ Applies same concepts and skills in a new situation ☐ Uses previous information to ask questions, propose solutions, make decisions, and design experiments			
Evaluate ☐ Answers open-ended questions by using observations and evidence ☐ Demonstrates an understanding of the concept(s)/skill(s) ☐ Evaluates his/her own progress and knowledge ☐ Asks related questions that would encourage future investigations			

☐ **References** (Curriculum materials used to write this lesson):

☐ **Web URL**(Find a relevant & worthwhile site for either teachers or students – list URL and **BRIEFLY** Describe):

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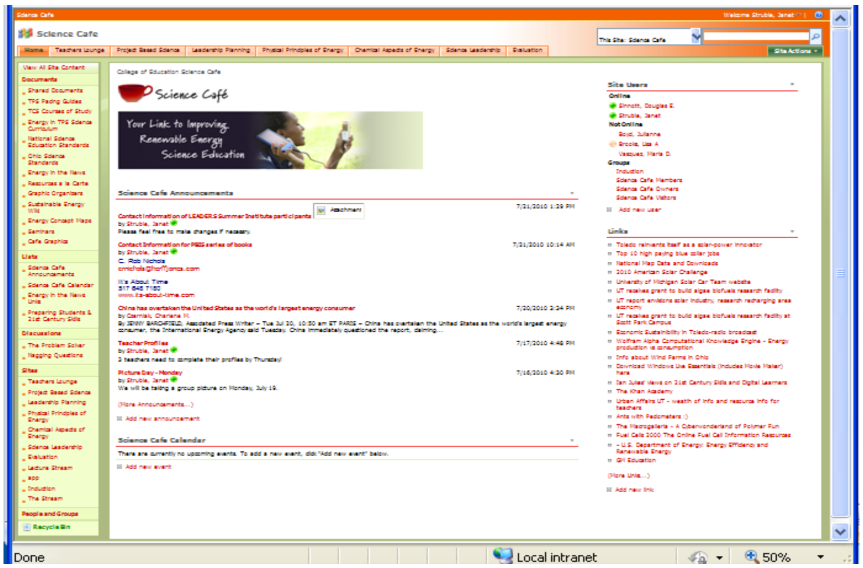
The *Science Café* (Figure 19) provides a location for each course: Physical Principles of Energy Sources, Project-Based Science, Chemical Aspects of Sustainable Energy and Science Leadership and Professional Development Design and the planning of a course labeled "Leadership Planning." An individual only sees the sites he/she has permission to access; for example, the teacher leaders do not see the "Leadership Planning" site. *Science Café* contains a site used for evaluation where teachers can take online surveys rather than exit the site and go to another site like *Survey Monkey* or *Question Pro*. The sites are listed along the left side and across the top. The "Home" page contains information that may be used in the course content courses. In the "Shared Documents" folder, the folders contain general information a teacher leader may need to teach a lesson on renewable energy. It was decided to have this type of general information listed on the main page. Areas of the *Science Café* were set up to facilitate teacher collaboration including "The Problem Solver," "Nagging Questions," and "Teachers' Lounge"

Figure 19. Main Page of Science Cafe



Each course website contains the following components listed in Table 6 and a snapshot of main page for content course: Physical Principles of Energy, is provided below (Figure 20).

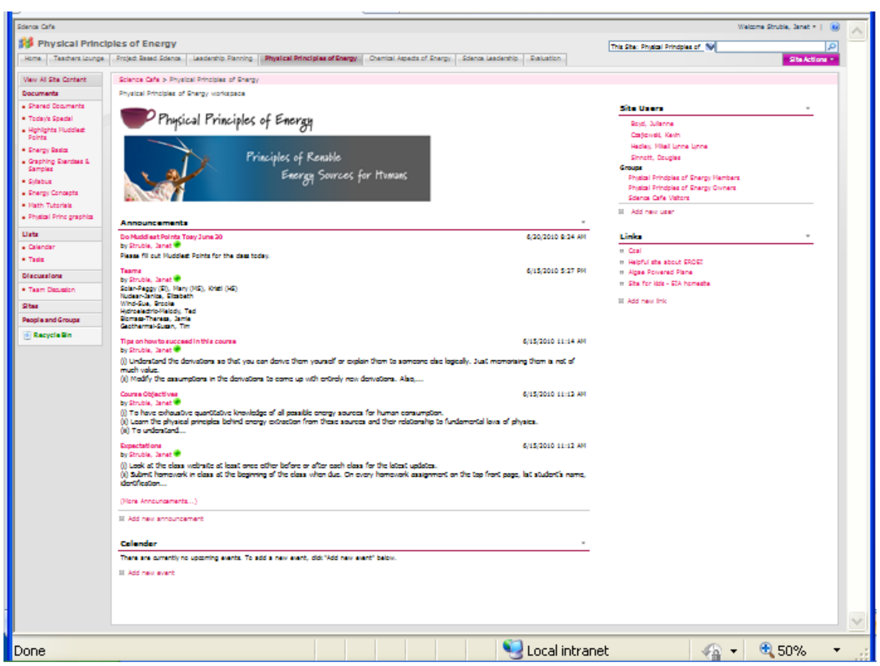
Table 6.

Course Website Components

Location	**Web part**	**Description of Contents**
Documents	Shared Documents	Place where teachers can post and edit documents; hand in assignments
	Today's Special	Site housing a folder for each day of class. The instructors post all documents used in class such as lesson plan(s), PowerPoint(s), graphic organizer(s), web links, etc. Teachers upload assignments due that day in the folder.
	Muddiest Points	Documents filled in and uploaded by the teacher leaders to inform instructors on points that need clarification
	Energy Basics Graphing Exercises Math Tutorials	Documents/sites added by the instructors to assist in the learning of content of the course

	Syllabus	Folder containing the syllabi for courses to provide easy access to refer to assignments, etc. Assignments are also posted on the calendar.
Lists	Calendar	Area for anyone in the course to post important dates pertaining to the course
	Tasks	Place where tasks can be assigned and monitored
Discussions	Team Discussions	Location where participants can discuss topics
Sites		Place to create a new list, library, discussion board, survey, page or site
Announcements		Site where anyone in the course can post an item for the group
People and Groups		List of people who have access to the course site
Site Users and Groups		Place listing group members and who is online within the *Science Café*
Links		Website links that contain information pertinent to the courses

Figure 20. Main page for content course: Physical Principles of Energy



The **Implementation** phase involves training individuals to use the site and launching the site. Training the users was a continual process depending on their schedules. Since the *Science Café* is being housed on the university's *SharePoint* site, access to the site was not given to us until the beginning of June. Gary Powell transferred all the materials from the trial version to the university's site within a couple of days. After *Science Café* was up and running on the university's *SharePoint* site, log in issues occurred and were resolved. To eliminate one of barriers in technology (mentioned earlier), each teacher leader received a Dell laptop computer (purchased from university department indirect overhead funds). Gary Powell attempted to provide some training for the teacher leaders on the *Science Café* using their new laptops during the orientation at Imagination Station, but this did not happen because the server had a firewall blocking outside access. Teacher leaders received training during lunch on June 14 and continually throughout the summer institute, which lead to some complaints that they were not free during lunchtime. The fire wall problem was ultimately resolved several weeks into the summer program. Science educators took the lead in showing teachers where documents were located and how to navigate the *Science Café*.

The **Evaluation** phase looks at the course including the online interactions with a critical eye. In regards to the *Science Café*, the designers received feedback verbally or in writing in email during and at the end of the summer institute from all parties involved (including teachers). Depending on the issue, one of the designers resolved it as soon as possible. For example, if it was a technical issue, Gary Powell dealt with it, whereas if it involved a course content issue like transferring files to folders in the course content site, Janet Struble assisted the professors or science educators. More evaluation of the *Science Café* will take place in the fall. The teacher leaders indicated that they would have liked training before the summer institute (evaluation report completed by Dr. Mentzer), however that was not possible because of the University's delays in launching *SharePoint* on the university server.

The next steps are to develop the *Science Café* to include interactions with community and business partners, develop new course content sections for the next summer institute, continue to support persons working within the *Science Café*, and incorporate additional features in the *Café*. The designers will use ADDIE to design a location, which will build an online community with teacher leaders and community/ business partners. Training will take place for the new group of scientists and science educators teaching in Summer Institute 2011. Gary Powell will provide the technical support for the teachers as they work from their schools; from past experience with working with the schools, Internet connectivity is a problem. Mr. Powell will also lead the discussions on what tools should be added next to the *Science Café*.

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Objectives and Scope

This section will describe the changes that have been made from our original proposal. Changes have occurred in our co-prinicipal investigator, the courses offered in the summer, and leadership courses.

Changes in Co-principal Investigator

Jan Kilbride, our co-principal investigator, retired from the Toledo Public Schools System on June 30, 2010. We would like Robert Mendenhall, director of science and technology, to be her replacement as co-PI, and we will be seeking this approval through Fastlane.

Change in Summer Load

Dr. Charlene Czerniak negotiated 2 months summer load with James Hamos, but needed to devote extra time to a US Department of Education grant, which went into a no cost extension. The USEd grant ends September 30, 2010, and Dr. Czerniak will devote the extra month's time on the LEADERS grant during summer 2011. This change was communicated with Dr. Hamos in Spring 2010.

Change in Course Offerings

As originally planned, three Earth Science courses were scheduled for summer II (2011) and two engineering courses were scheduled for summer III (2012).

The original list of courses for Summer Institute II in the summer of 2011 was the following:

Table 7.

Original Course List for Summer Institute 2010

Title	Instructors
Earth System Science	Dr. Kevin Czajkowski
Earth Technologies	Dr. Donald Stierman
Climate Change	Dr. Patrick Lawrence
Science Leadership & Professional Development Design II	Dr. Charlene Czerniak
Seminars	Community & Industry Partners

We decided to have Dr. Glenn Lipscomb offer the Biofuels course in Summer Institute 2011and Dr. Czajkowski moved the Earth System Science course to Summer Institute 2012 from Summer Institute 2011. This change will even out the course offerings so that there is a better balance between engineering and science courses. In addition, the Earth System Science course will now be offered as a capstone for the teachers, which will include the Masters project needed to complete their Masters degrees.
The Summer Institute II schedule for 2011 now is the following:

Table 8.

Revised Course List for Summer Institute 2011

Title	Instructors
Biofuels	Dr. Glenn Lipscomb
Earth Technologies	Dr. Donald Stierman and Kevin Czajkowski
Climate Change	Dr. Patrick Lawrence
Science Leadership & Professional Development Design II (RESM)	Dr. Charlene Czerniak
Seminars	Community & Industry Partners

Clarification of the Content for Leadership Classes

After the decision was made to have the LEADERS courses culminate to a Masters degree, Kevin Czajkowski, Charlene M. Czerniak, and school partners discussed the ways in which the Masters program requirements could become part of the LEADERS program without adding more course work and financial expense for the teachers. The program for the Masters of Arts and Education in Geography at The University of Toledo requires students to enroll in one course from each of the following areas in the Judith Herb College of Education: curriculum and instruction foundations (CI), psychological foundations (EDP), research foundations (RESM), social foundations (TSOC), and 24 credit hours of geography or related course work. The Leadership Classes scheduled for years 1, 2, and 3 were redesigned to fulfill the EDP, RESM, and TSOC course requirements, respectively. It is our goal to introduce to the university curriculum committee a concentration in renewable energy in the Masters of Science and Education degree. The group decided to design the Leadership classes from psychological foundations (EDP), research foundations (RESM), and social foundations (TSOC) points of view.

The leadership class for the first year was created to answer the following driving question: How do project-based science and the science content come together to make you a leader in your school district? In Year 1, the *Science Leadership and Professional Development Design* focused on topics from a psychology perspective. For example, the leader teachers studied how people learn in general and specifically how students learn science. In the professional development sessions, student learning was linked to the features of project-based science that facilitate student learning and the pedagogical methods teachers would employ in the classroom. Other topics included learning from a cognitive point of view, motivation, change theory, and adult learning theory.

In Year 2, the leadership class will take a research and measurement perspective. The driving question for the course will be “How do you know your students are learning science?” For example, teacher leaders will gather evidence of student learning, analyze the results, and revise lessons and assessments to increase student learning. Teacher leaders will also learn how to analyze data from state and national science tests/assessments.

In Year 3, the leadership class will focus on topics from sociological point of view. The driving question will be “Are *all* students learning science?” The teacher leaders will focus on differentiating science instruction to meet the needs of all learners.

Figure 21 illustrates the concept behind the organization of the courses:

Figure 21. Years One, Two, and Three Design

Appendix

NSF MSP LEADERS Project

Evaluation Report

Year One

September 1, 2009 -August 1, 2010

Prepared by

Gale A. Mentzer, Ph.D.
Project Evaluator
&
Lisa A. Brooks, Ph.D.
Evaluation Post-Doctoral Assistant

August 2010

TABLE OF CONTENTS

This report summarizes the activities and finding of the evaluators of the NSF MSP project entitled LEADERS from September 2009 through August 2010.

Executive Summary

The Year 1 LEADERS project evaluation consisted of the collection of baseline data from the teacher leaders, the determination of whether teacher leaders gained content knowledge during the summer institute, and the collection of formative assessment data as to the general operation of the Summer Institute.

The baseline data consisted of direct observation, the *Science Teacher Self-Efficacy Instrument (A)*, and a project-developed *Leadership Responsibilities, Confidence, and Competency* survey. The data collected and compiled from these sources provided a rich picture of each teacher leader prior to participation in the LEADERS project. In general, the teacher leaders were adequate science teachers who used some investigative, inquiry-based instructional practices. While the majority had average to above average confidence in their ability to provide effective science instruction, they did not, as a group, feel that effective instruction alone could improve student science achievement. Prior to participation in LEADERS, none of the teachers held a great deal of the type of leadership responsibility that they will hold as a teacher leader although they were confident that they were up to the task. Some areas that they felt they needed more knowledge and skill in order to be effective teacher leaders included designing and presenting professional development linked to energy issues, understanding the needs of policy makers, understanding science education research, and knowledge of the needs of science teachers in their districts.

Comparisons of teacher leader pretest and posttest scores on renewable energy content covered during the Summer Institute, *Physical Principles of Energy Sources for Humans* and *Chemical Aspects of Sustainable Energy*, showed statistically significant gains for teacher leaders in both courses. Knowledge gains in *Project Based Science* will be assessed through examination of lessons developed by the teacher leaders during the academic year.

Feedback collected through a focus group interview at the conclusion of the Summer Institute revealed that the teacher leaders were happy with their summer experience but suggested an Institute schedule that facilitated more collaboration among the teacher leaders and balanced class time with appropriate field trips and guest speakers. Specifically, they hoped LEADERS senior project staff might consider more flexible or creative ways of offering the content courses in the summer (rather than three weeks every morning per class) so that time to work in groups or go on field trips can be integrated into the courses rather than stand-alone outside the courses.

The science education expert, Janice Koch, Ph.D., provided the evaluation team with suggestions for the coming year including exploring a means by which to specifically address participants' understanding of the ways to link science content to emerging local science–based industries in their grade-level science curriculums. Upon her recommendation, we will be adding this element to our Project Based Science Lesson rubric.

LEADERS Evaluation Model

Table 1 presents the components of the LEADERS evaluation plan that have been completed during the first year of the project. In addition, the evaluation team completed pre-participation classroom observations of the teacher leaders and STEBI-A and Leadership Responsibility and Confidence surveys to establish a baseline to measure teacher leader growth over time. This report provides the details of the data collected to date.

Table 1: LEADERS Year 1 Evaluation Outcome Measures

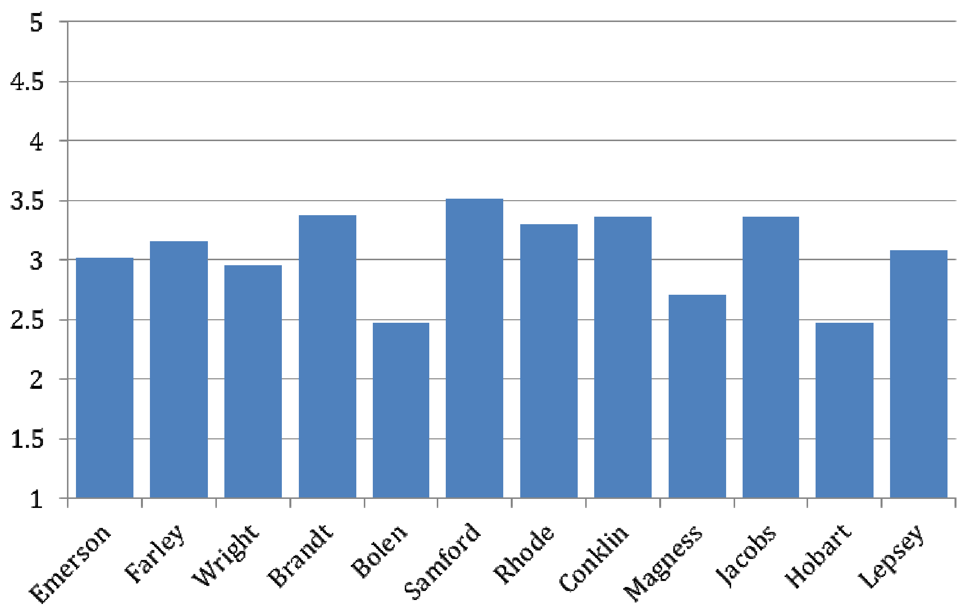
Goal	Outcome	Measure	Source	Beginning date	Frequency	Type
1,2,3	Participant understanding of application of course content to the 4-12 classroom.	Qualitative data collected from focus group interview	Evaluator	Jun-10	annually	Formative
1,2,4	Participant perception of teamw ork opportunities w ith one another	Qualitative data collected from focus group interview	Evaluator	Jun-10	annually	Formative
1,2,5	Participant perceived value of teacher/community collaboration	Qualitative data collected from focus group interview	Evaluator	Jun-10	annually	Formative
1, 2, 3	Increased content know ledge--participants	Faculty prepared tests of content	Project developed	Jun-10	As courses are offered	Formative (annual) Summative (aggregated)

Science Teacher Efficacy Beliefs Instrument (A) Baseline Measures

One measure of a teacher leader's motivation to enact change within their classroom as well as their district is the belief that what is done will have a positive effect. Bandura (1977) referred to this as outcome expectation. Coupled with outcome expectation is the confidence that the person can perform the action successfully. This is the self-efficacy expectation (or personal beliefs). The Science Teacher Efficacy Beliefs Instrument (STEBI-A) was developed by Enoch and Riggs (1988) to measure both constructs in practicing teachers and the comparison of scale scores over time can be used to make assumptions about changes in science teaching self-efficacy. The five point rating scale provides an ordinal score (ranked) with a "1" indicating low outcome expectation and self-efficacy expectation and a "5" indicating a high level of each construct. High scores on each scale indicate a high level of perceived self-efficacy in science teaching and suggest that the teacher leaders are more likely to pursue LEADERS goals of providing science teachers with professional development in integrating renewable energy science into their classrooms using a project-based instructional approach.

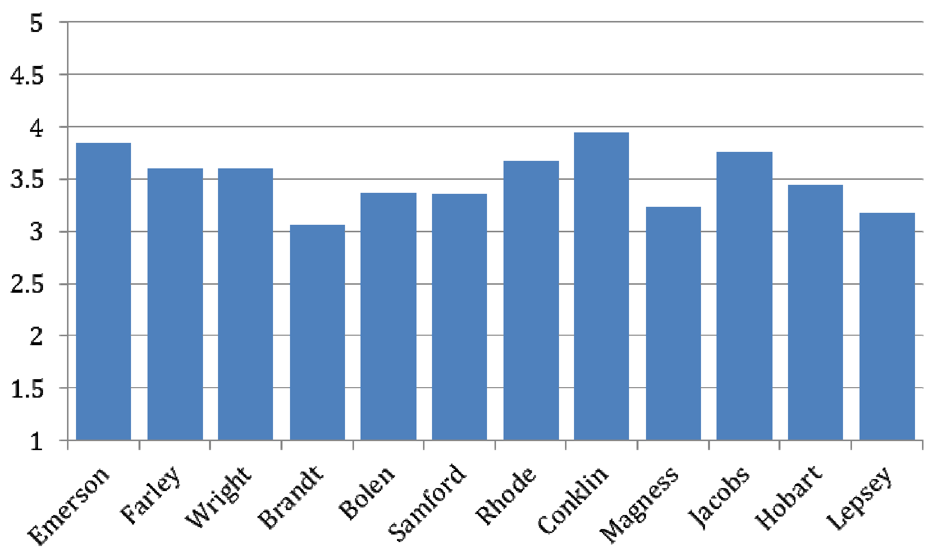
Because the STEBI scale is ordinal, it is inappropriate to calculate mean scores and make comparisons between scores using parametric analyses. To correct for this, we utilized Rasch modeling to convert the ordinal scores to an interval scale. The conversion used a mean score of "3" to reflect the original STEBI rating scale where "3" indicated undecided or neutral (neither agree nor disagree) and a logit of 0.25 in order to see separation between the respondents. The results can be seen in Tables 1 and 2 (teacher leader names are fictitious to protect anonymity):

Table 2: LEADERS Participant Baseline Expectancy Outcomes Scores



The average score on the Expectancy Outcomes scale was 3.07 or just slightly higher than a neutral score with a standard deviation of 0.10 indicating that there is little variability between the highest and lowest scores. This suggested that the teacher leaders, prior to participation in the project, did not, in general, have positive expectancy outcome beliefs.

Table 3: LEADERS Participant Baseline Self-Efficacy Expectations Scores

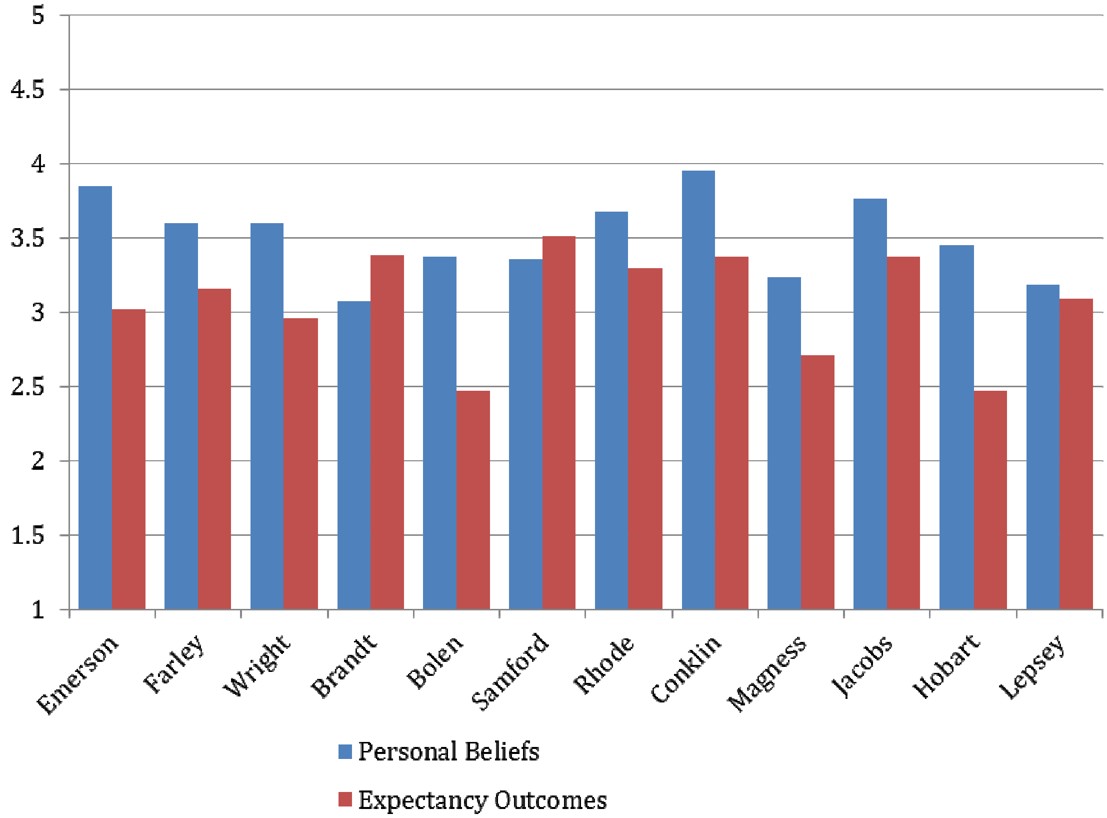


Average score on the Self-Efficacy Expectations or Personal Beliefs scale was 3.57 with a standard deviation of 0.28 indicating a slightly positive belief in their confidence that they can teach science effectively. The standard deviation indicated that there was little variability between the participants' scores.

A more revealing view of the baseline scores, however, can be seen when each participant's score on both scales are paired side by side (Table 3, next page). The percent of shared variance between the group's scores on the two scales (r^2) was 0.05 suggesting that there is practically no relationship between the participants' beliefs that effective science teaching will have a favorable result and their confidence that they can teach science effectively. Only two teachers (Brandt and Samford) had higher scores for outcome expectations than for personal beliefs. When the outcome expectation score is higher than the personal belief score, there is a positive attitude towards enacting effective science instruction but the teacher is not as confident in his/her ability to perform that action. For those teacher leaders who showed the most variance between the scale scores (e.g., Hobart, Emerson, and Bolan) there may be an expectation that regardless of their effectiveness as a teacher or the instructional strategies utilized, students may not learn science because there are elements of learning that the science teacher cannot affect (such as an inadequate science background).

The STEBI will be administered to the teacher leaders annually to measure science teacher efficacy growth. It is expected that scores on both scales will increase as a result of participation in LEADERS.

Table 3: LEADERS Participant STEBI Paired Scale Scores



LEADERS Leadership Baseline Data

The measurement of leadership skills development, implementation, and achievement will be accomplished through a triangulated method that employs both quantitative and qualitative data collection as well as a complement of participant self-reporting, feedback from those who work with the teacher leaders, and direct observations. Prior to the commencement of the Summer Institute, teacher leaders completed a self-reported baseline leadership survey that was adapted from the teacher leadership survey developed by the Georgia Partnership for Reform in Science and Mathematics (PRISM) and funded by the National Science Foundation. No information concerning reliability or validity was available; however, LEADERS evaluation team will conduct reliability and validity analyses using Rasch modeling once an adequate sample size has been obtained (central limit theorem recommends a minimum of 30 responses).

The LEADERS version of the survey first asked how much responsibility the teacher leaders had for specific duties associated with teacher leadership and the LEADERS project (see Appendix for specific questions) and then asked how comfortable they were engaging in these same activities. Responses utilized a 5 point rating scale that ranged from “a great deal of responsibility” to “no responsibility” for the first battery of questions (responsibility scale) and “very comfortable” to “very uncomfortable” for the second section of questions (confidence scale). Rasch analysis was employed first to validate the response scales as the response selection was questionable for **the responsibility scale** (a great deal; a moderate amount; some; very little; none). It was suspected that the terms “moderate, some, and very little” may have been interpreted as representing a variety of values for the respondents. This proved to be true as can be seen in Diagram 1 below where response curves for the above mentioned categories (4, 3, and 2 respectively) showed a great degree of overlap.

Diagram 1: Leadership Survey 5-Point Response Probability Map

```
CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
R  1.0 +                                                              +
O      |                                                            55|
B      |11                                                       555  |
A      |  111                                                 555     |
B   .8 +     11                                              5        +
I      |       1                                           55         |
L      |        1                                         5           |
I      |         11                                      5            |
T   .6 +           1     22222222                      55             +
Y      |            1  22        2                    5               |
    .5 +             12            22          4444  5                +
O      |             21              2  3    44    4*                 |
F   .4 +           22  1             3*3 3334      5 44               +
       |          2     11         33  2   433    5    44             |
R      |        22         1     3      244   3  5       4            |
E      |       2            1   33      42     3*         44          |
S   .2 +     22              113       4  2    5 3          44        +
P      |  222                3311    44    2255   33          44      |
O      |22                333     1144     5522     33          4444  |
N      |             33333     44441111 555    222    3333          44|
S   .0 +***********************55555555*1111111111********************+
E      -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
      -50   -40   -30   -20   -10     0    10    20    30    40    50
```

Categories “moderate amount” and “some” (4 and 3) were collapsed into one category based upon the response probability map as well as upon word connotations suggesting that these two phrases could be easily interchanged. The probability curves for resulting four categories showed cleaner separation of responses:

<u>Diagram 2: Rescaled Leadership Response Categories (Responsibility Scale)</u>

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 CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      -+--------------+--------------+--------------+--------------+-
R  1.0 +111111                                                   4444+
O      |      1111                                           4444    |
B      |          11                                      444        |
A      |            11                                   4           |
B   .8 +              1                                 4            +
I      |               1                  33333        4             |
L      |                1               33     3      4              |
I      |                1      22      3        3    4               |
T   .6 +                 1   22  22   3          3  4                +
Y      |                  1 2      2 3            34                 |
    .5 +                   *        23            34                 +
O      |                  21        32            43                 |
F   .4 +                 2  1      3  2          4  3                +
       |                 2   1    3   2         4    3               |
R      |                2    1    3    2        4     3              |
E      |               2      1  3      2      4       3             |
S   .2 +              2        13        2    4         3            +
P      |            22         31        2244            3           |
O      |          22         33  11      4422             333        |
N      |      2222        333      111 444    222            3333    |
S   .0 +******************444444444444*1111111111********************+
E      -+--------------+--------------+--------------+--------------+-
       -2             -1              0              1              2
```

Based upon the recalibrated scale, interval scores were calculated using an expected mean of 2.5 and a 0.1 logit. The higher the score, the more responsibility the teacher leader had. The mean score for the 12 teacher leaders was 2.64 (sd = 0.14) with scores ranging from 2.35 to 2.87 Teacher leaders scored above the expected average on the leadership responsibility scale but in general only slightly above. Only two leaders scored below the expected mean (see discussion on individual participant’s baseline data section).

A similar analysis was conducted for the **confidence scale** (“How comfortable are you doing the following . . .?). Responses for this section included: “very comfortable”, “comfortable”, “neutral”, “uncomfortable” and “very uncomfortable” (again, the higher the score, the more comfortable the teacher leader felt). Results showed that the category, “very uncomfortable” was not used. Future use of this survey will explore a recalibration to a four point scale that simulates the responsibility scale (two positive choices and two negative choices thereby eliminating the “neutral” response or one positive, one neutral, and one negative response choice). For the current analysis, however, the five point scale was retained because eliminating the “very uncomfortable” category positively skewed the responses (two positive response choices versus one neutral and one negative choice).

The group mean for the comfort scale was 3.72 on a scale with an expected mean of 3.0 (.25 logit) and a standard deviation of 0.76. Scores ranged from 5.15 (two respondents) to 2.41. Two respondents scored below the expected mean. It is important to remember that these scores are scaled and therefore may reflect values outside of the original rating scale due to the model employed. This is why two outliers scored above the expected limit of 5. These two leaders have much higher confidence levels than their peers (see individual participant's baseline data section).

There appeared to be little relationship between scores on the responsibility and confidence scales. The r^2 or percent of shared variance between the two scales was 0.55 indicating a moderate positive relationship but not suggesting strong shared variance. The conclusion that can be drawn is that the responsibility to carry out specific tasks has some but not a significant relationship to the teacher leader's level of comfort to actually carry out the task. In general, the teacher leaders were confident they can carry out their new responsibilities as teacher leaders even though they have not had a great deal of experience doing so (at least not currently).

A final section of the leadership survey explored teacher leaders' perceived **skill and knowledge levels** pertaining to a variety of duties and responsibilities associated with the LEADERS project (see survey in Appendix). This 14-item section again used a 5-point rating scale. Each item began with "I have the knowledge and skills to . . ." and was followed by a responsibility or duty such as "discuss education-related policies with policy makers (e.g., superintendents, government officials, etc.)". Respondents chose from "strongly agree", "agree", "neutral", disagree", and "strongly disagree". On this scale, a higher score indicated a higher perceived level of knowledge and skill competency.

The group's mean on this scale was 3.33 (slightly above the expected mean for knowledge and skills—3.0) with a standard deviation of 0.32. Scores ranged a little over one point from the self-perceived most skillful/knowledgeable teacher leader (3.75) to the least (2.66). Recalling that this survey was administered *prior* to the Summer Institute, the following topics reflected the least perceived levels of skills and knowledge:

- I have the knowledge and skills to design and provide professional development to experienced teachers about energy issues.
- I am knowledgeable about the needs of policy makers (e.g., superintendents, government officials, etc.).
- I have the knowledge and skills to discuss education-related policies with policy makers (e.g., superintendents, government officials, etc.)
- I have the knowledge and skills to help experienced teachers understand and teach about energy issues.
- I have the knowledge and skills to discuss educational research with science education researchers.
- I have the knowledge and skills to write curriculum about energy issues.
- I am knowledgeable about the needs of science teachers in my district.

The Leadership Survey will be administered annually throughout the duration of the project. Eventually a repeated measures analysis will be conducted to examine growth over time.

Teacher Leader Baseline Observation & Individual Survey Scores

A) *Methods*

Classroom observations and interviews of the twelve teacher leaders accepted to the LEADERS Project were conducted before the 2010 Summer Institute began. The teacher leaders were sent a formal acceptance letter by the project team mid-April 2010. This letter asked them to contact evaluator Brooks to schedule a time for a classroom observation on a day when they would be teaching an "investigative or inquiry-based science lesson" and to allow his or her class to be either video or audio-recorded. A few days before the scheduled observation the teachers were sent a short survey (see Appendix) that explored the learning goals of the lesson, how it fit into the larger picture of science instruction, and the students' science and demographic backgrounds. Each observation was followed up with a short post-observation interview to better understanding the teacher's school context, planning behaviors and how the lesson fit into their overall curricula.

Two instruments were used in addition to detailed descriptions to capture the complexity of the observed science lessons: The *Inside the Classroom Observation and Analytic Protocol* (ITC COP) (Horizon Research Inc., 2000) and the *Mathematics and Science Classroom Observation Profile System* (M-SCOPS) (Stuessy, 2002). The ITC COP has been widely used in NSF MSP evaluation and provides a standardized and validated method to evaluate teachers' practices and compare cross- project impacts. The ITC COP (see Appendix) provides numerical scores for a given lesson on five scales that align with reform-based recommendations for science instruction from such documents as the National Science Education Standards (NSES) (National Research Council, 1996). The picture it provides of teachers' classrooms is focused on distinct features of classroom practice that reflect a particular view of science instruction based on underlying assumptions about reform-based teaching (Henry, Murray, and Phillips, 2007). However, to assess the intended as well as unintended outcomes of integrating project-based science lessons framed by sustainable energy content on teachers and schools, a richer qualitative view of the teacher's classrooms was needed. The evaluation team decided to supplement ITC COP with detailed descriptions of the observed lessons coupled with M-SCOPS Profiles (Stuessy, 2002).

The M-SCOPS provides a visual representation of what occurs in an observed lesson. The resulting Profiles or maps focus on broad characteristics of a teacher's classroom practice that include: (1) How much control students have for their learning; (2) Tthe focus of instruction on lower or higher order skills; (3) How parts of the lesson are broken up; and (4) How the parts of the lesson fit together. These features allow multiple facets of teachers' classrooms to be easily compared and facilitate the discussion of differences. An in-depth discussion of the features and use of the M-SCOPS instrument is provided before the cases of the teacher leaders are presented.

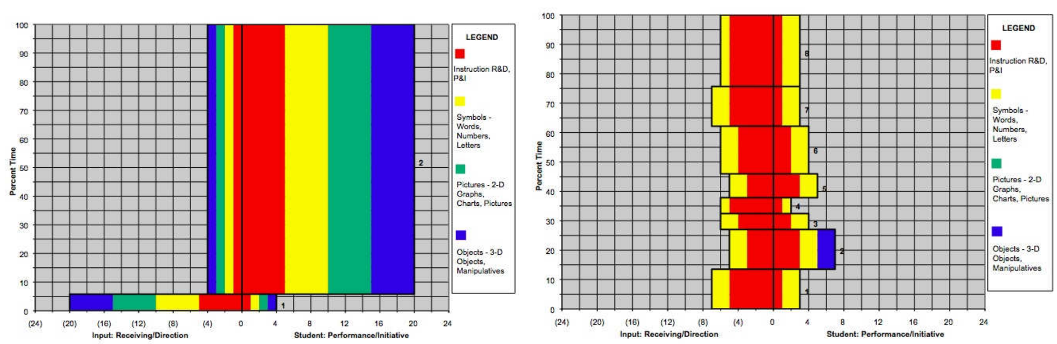
M-SCOPS Use and Interpretation

The M-SCOPS Profile depicts four dimensions of what occurs in a classroom: instructional scaffolding, representational scaffolding, segmentation, and flow. When these four elements are combined in the pictorial representation of a science or mathematics lesson, the researcher can go beyond description to a more holistic analysis of the lessons in which overall patterns within and between the lessons of different teachers can be seen and interpreted.

Reform-based ideas about science teaching, such as those discussed in the National Science Education Standards (National Research Council, 1996), call for a shift in perspective from teacher action to student learning. Therefore, the primary focus of the M-SCOPS is on the students' actions during a given lesson. The Profile is divided into two "halves." The left half of each Profile represents information students are *receiving* and/or actions they are being directed to perform (R&D). The right half of each Profile represents what the students are *doing* themselves through actions they are performing and the initiative they are taking to enhance their own learning (P&I). Both sides of the Profile have other features coded through segments and colors that are interpreted to represent the four dimensions of a classroom as listed above.

The first of those four dimensions is that of instructional scaffolding (IS), depicted by the central red band. The IS band remains the same width throughout the M-SCOPS Profile and its placement, more to the left or right of the median line, represents one of six levels of student centeredness (Table 4). If students are doing the majority of acting, or performing, and taking more initiative for their learning the red band would be more on the right, or the P&I side of the graph (Figure 1, map on left). If students receive a lot of information, in a lecture, for example, the majority of the red band would be on the left side, or the R&D side of the graph (Figure 1, map on right). An example of this type of instruction occurs when some students read what is written on the board while other students passively listen.

Figure 1: Sample M-SCOPS Map—Instructional Scaffolding

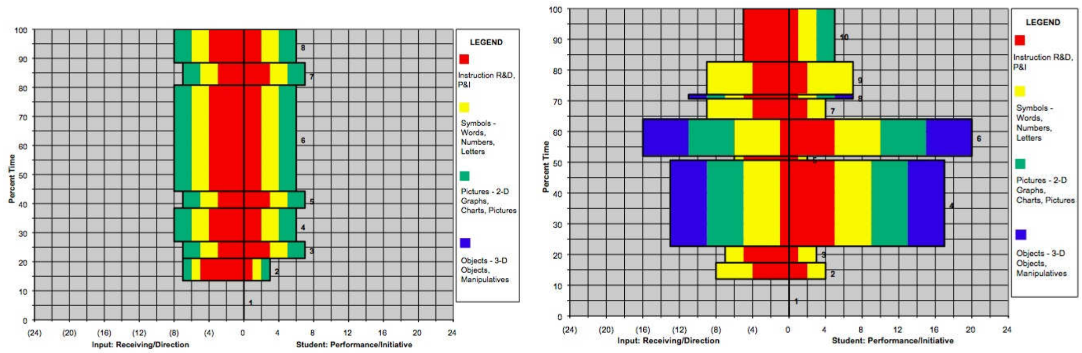


The second dimension of an M-SCOPS Profile is representational scaffolding (RS), depicted by the yellow, green and blue bands. RS refers to the representation of the content students are receiving and/or acting upon. There are three different types of RS represented by the three different colors of the RS band. Yellow depicts the use of words and symbols, green depicts the use of 2D images such as pictures, graphs and charts, and blue depicts the use of 3D objects or manipulatives. The width of the RS band demonstrates which of six levels of thinking complexity the students are using while working with the materials they are given (Table 5). For example, in the M-SCOPS Profile depicted in the map on the left of Figure 2, all segments but the first have both yellow and green RS bands. These segments reflect that students are reading and listening as they look at the 2D pictures of frog body systems on their worksheets. For the majority of the class the colored bands are two units wide as students spend the majority of the period focused on labeling the diagrams, and telling their answers to the class, both of which are found in the 2nd level of RS complexity aptly called "replicate."

Table 4: M-SCOPS Levels of Instructional Scaffolding Strategies (Stuessy, 2002)

R&D/P &I	*Instructional Strategy*	*Examples*
5/1	Individual students are directed to listen as the teacher or another student talks to the entire group; students are directed to read or do seat work; assimilation and/or accommodation occur passively with little or no interaction with others	Direct instruction models, including those where the teacher asks rhetorical, yes-no or one-word answers; lecture, silent reading, independent practice, seat work
4/2	Individual students respond orally or in writing to questions asked by the teacher, in whole group	Teacher-led recitation; question and answer; discussion led and directed by the teacher
3/3	Students in pairs or small groups work together under the teacher's supervision – with discussion; all groups do basically the same task	Student discussion in groups; may include task completion, verification laboratories, cooperative learning models
2/4	Groups and/or individual students work on different tasks with some choice; loosely supervised by the teacher	Student- or group-initiated work on options or suggestions provided by the teacher; while options provide choice in "centers" or learning situations, the teacher has structured the choice
1/5	Students in pairs or small groups discuss, and/or formulate their own plans for working in class on a specified task; minimal supervision	Open-ended laboratory or project work, invited by the teacher, but definitely where students are less restricted
0/6	Individuals or groups carry out their own work independently; minimal supervision	Individualized laboratory or project work

Figure 2: Sample M-SCOPS Map—Representational Scaffolding



If we look at the M-SCOPS Profile presented in Figure 2 (map on right) we see all three colors present in segments four and six. These segments of the M-SCOPS Profile represent the portion of the class in which students are designing the methods that they will use to prove water vapor is in the classroom air and carrying out their experiments. During these activities students are using all three types of RS. They are using words and symbols as they talk with one another and develop their ideas, they are using pictures as they draw their experimental set up on paper to show to Amanda, and they are using 3D objects as they carry out their experiments. The colored bands in these segments are six units wide since the students are generating new ideas and performing many of the types of thinking that can be found in the 6^{th} level of RS complexity, aptly called “generate.”

Looking at the profiles as a whole reveals the third and fourth dimensions of the M-SCOPS Profile—segmentation and flow. Segmentation refers to the breaks in activity that students are given. Each segment is noted by a different number listed to the right of the segment on the map and often a shift in the levels of IS and/or RS.

When viewed together and pictorially in an M-SCOPS Profile, these four dimensions of a teacher’s class can provide an equitable method to compare what is going on in each. As the teachers’ lessons are described and the Profiles representing them are seen, stark differences in the ways they teach and the flow of their lessons are evident.

Table 5: Complexity Levels of Representational Scaffolding (adapted from Stuessy, 2002, p. 6)

Action	*Level (Code)*	*Receiving*	*Acting*
Attend	1	External or superficial features, attributes, directions to perform a level 1 action	Listen to, attend to, observe, watch, read, view
Replicate	2	Pictures, models, examples, identifications, descriptions, explanations, clarifications, calculations, duplications, measurements, reproductions, demonstrations, algorithms, level 2 directions	Recall, remember, list, tell, label, collect, examine, manipulate, name, tabulate, identify, give examples, describe, explain, clarify, calculate, document

Action	*Level (Code)*	*Receiving*	*Acting*
Rearrange	3	Comparisons, groupings, sequences, patterns, rearrangements, balancing, classifications, disassembled parts of a whole together, level 3 directions	Compare, group, put in order, rearrange, identify a pattern, paraphrase, balance, classify, identify parts of a whole, assemble parts to make a whole, disassemble parts of a whole
Transform	4	Different representations of the same system; arrangements of complex parts into a whole system transformation, changes, level 4 directions	Represent symbolically or pictorially, experiment, interpret, contrast, apply, modify, make choices, distinguish, differentiate, transform, change, arrange complex parts into a system
Connect	5	Alternative points of view, connections, relationships, justifications, inferences, plans, hypotheses, analogies, systems, models, solutions to complex problems, level 5 directions	Connect, associate, extend, illustrate, explain relationships in a system, use and/or connect representations to develop explanations, explain different points of view, infer, predict, plan, analyze, generate solutions to complex problems already conceived
Generate	6	Analyses, evaluations, summaries, conclusions, abstract models and representations, problem scenarios, level 6 directions	Justify, defend, support one's own point of view, develop or test one's own hypotheses or conceptual models, define relationships in new systems, generalize, recommend, evaluate, assess, conclude, design, generate a problem, solve a problem of one's own generation

In the twelve cases that follow, differences among the teachers' lessons are more readily apparent from the M-SCOPS Profiles than from descriptions of the lessons alone. These differences include the number of segments in a lesson, the level of IS, the type and level of RS, the overall complexity of the lesson, and the amount of time wasted during lessons. The Profiles give us a starting point, an easy method of comparing these baseline observations to future observations, and add to the overall description and analysis of the cases included in this initial data collection phase.

References

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B) <u>Descriptions and Analyses of Baseline Observations</u>

Descriptions of the baseline observations of the twelve teachers selected to be participants in the LEADERS Project follow. The descriptions are qualitative in nature and are often written in first person from the point of view of the observer. Following each description is a brief analysis of the M-SCOPS Profile, the ratings the lesson was given on the ITC COP, and individual teacher's scores converted to an interval scale (using Rasch analysis) on the STEBI-A and baseline leadership surveys. The actual M-SCOPS map for each teacher is provided at the end of their respective sections. The names of the teachers are fictional to protect their privacy. This section concludes with a synthesis and comparative analysis to facilitate a discussion of patterns and trends among the cases.

1. Toledo Public Schools Teacher Leaders

Beverly Magness – TPS Case #1

At the time of this study Beverly was a Biology teacher at a public high school where 77% of students were minority and 62% were considered economically disadvantaged. Beverly had been a teacher for four years and had spent all of those years at her current school. In planning for my visit she asked if I would rather see a lesson that was more typical of her day-to-day teaching or a frog dissection, which she considered a good example of investigative science. She was worried that the frog dissection would not be an easy class to observe and so we decided I would come the day before as she prepared students for the dissection lab. There were approximately 20 students in this class, about half of which were Black and about half were female.

Observation Description

Beverly welcomed me into her classroom and gave me a handout indicating that during the lesson students would be making a “frog sandwich” by labeling the parts of various frog body systems on a series of worksheets.

Most students were in their seats when the bell rang. Announcements came over the intercom system and Beverly spoke with a few students individually before she began class (segment 1). Class began with a short review of amphibian characteristics and a description of the worksheets they would be completing that day. As she passed out the worksheets, Beverly brought her students’ attention to a chart at the front of the room that would be used during class to compare the similarities and differences between humans and frogs (segment 2). Students were given a few minutes to work with their neighbors and complete the first worksheet about external characteristics (segment 3). Students were then asked to give their answers for each part, and the teacher asked students questions and gave information about the parts function and how it compared to the human body (segment 4). Students were again given a few minutes to work with a neighbor to work on filling in the names of parts of the frog’s skeletal system (segment 5). Once again the class was brought together to discuss their answers on that sheet and details of some of the parts (segment 6). During this segment students also worked on completing the third worksheet on the frog’s nervous system and parts were discussed as a whole class as they worked. After they completed the nervous system sheet, students were given another few minutes to complete the worksheet on the frog’s internal organs (segment 7). Class concluded with a discussion of the correct part names on this worksheet, as well as details about the parts and a comparison of human and frog heart (segment 8).

M-SCOPS Analysis

The M-SCOPS Profile that represents Beverly’s lesson is provided in Figure 3. This 52-minute lesson consisted of eight segments. The first segment, which composed 13.5% of the total class time, was a segment in which no formal instruction took place. This segment was intentionally left blank to show that class time was not utilized to the fullest extent and is not calculated into percentages discussed in this analysis as instructional time. The remaining 86.5% of class time was broken into seven segments that alternated between whole class discussion and small group work. Seventy-nine percent of this instructional time was spent at a level "5/1" or "4/2", with students working in small groups for the remaining 21% of time. Through all of these segments students were focused on words and pictures at RS levels of one or "attending" and two or "replicating" as they labeled parts and received answers. The class ended with no closure or opportunity for reflection or synthesis of what was learned.

ITC COP Analysis

Design Score: 2

This lesson was teacher-directed and focused on identifying and naming parts of the frog's external and internal anatomy. Students were given several worksheets that diagramed different frog systems and used their textbooks to fill in blank spaces near different anatomical features. Students spent 19% of instructional time working in small groups to complete the sheets and 60% of class time reviewing the answers as a class. While this lesson did accomplish the goals of instruction, the goals and strategies used were not consistent with reform-based ideas about investigative science. Students' group work was mainly focused on the lower level skills of identifying and naming parts.

Implementation Score: 3

This lesson was well managed and taught; however, it was inconsistent with investigative science. This inconsistency could be seen in the high level of teacher direction (68% of total class time and 79% of instructional time were spent at a level "5/1" or "4/2") and focus of students on lower-level skills (86.5% of total class time and 100% of utilized class time were spent at a level 1 or 2). This focus gave little opportunity for students to critically think about the content or engage in problem solving activities. While some degree of "sense making" went on during class, it was limited and inconsistent. The absence of a closure segment in the M-SCOPS Profile demonstrated that there was little time for students to synthesize what they learned or "wrap up" the day's lesson.

Content Score: 3

This lesson focused on students identifying and naming various parts of frog anatomy. The teacher made several connections to similarities and differences between human and frog systems but these connections were surface level and inconsistent. While anatomy is an important part of the biology curriculum, the focus of this lesson provided little opportunity for students to connect ideas or for science to be portrayed as a dynamic body of knowledge.

Classroom Culture Score: 2

The activities included in this lesson provided little opportunity for the types of interactions consistent with investigative science. The high level of teacher direction (79% of instructional time) and focus on low level activities (100% of instructional time) that were characteristic of this lesson were evidence of this. Beverly managed her classroom well and students were on-task and respectful of each other and the teacher throughout the lesson.

Capsule Description: Level 2 – Elements of Effective Instruction

The lack of alignment this lesson had with the characteristics of investigative science that drive the ITC COP led to a level 2 capsule score. While instruction was purposeful and the classroom was well managed, little opportunity for students to make sense of ideas or connect ideas across disciplines were evident. Additionally, the high level of teacher direction left little opportunity to for students to engage in "doing" science, and overall the lesson appeared quite limited in its likelihood to enhance students understanding of science as a dynamic field.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.24	2.71	2.59	3.38	3.16

Beverly's responses to the Personal Beliefs scale of the STEBI instrument were above the expected average. Her responses to the Outcome Expectancy scale, however, were below the expected average. These results suggested that while Beverly held positive beliefs about her ability to provide effective science instruction, she did not believe that a teacher's actions had a large influence on student learning. Her responses to the leadership survey indicated that, prior to the onset of the Summer Institute, she played a minor leadership role in her district but had the confidence that she would be able to succeed in her role as a teacher leader. Her responses to the questions about knowledge and skills indicated that she believed she had an average level of knowledge and skill with regards to the activities associated with the LEADERS Project.

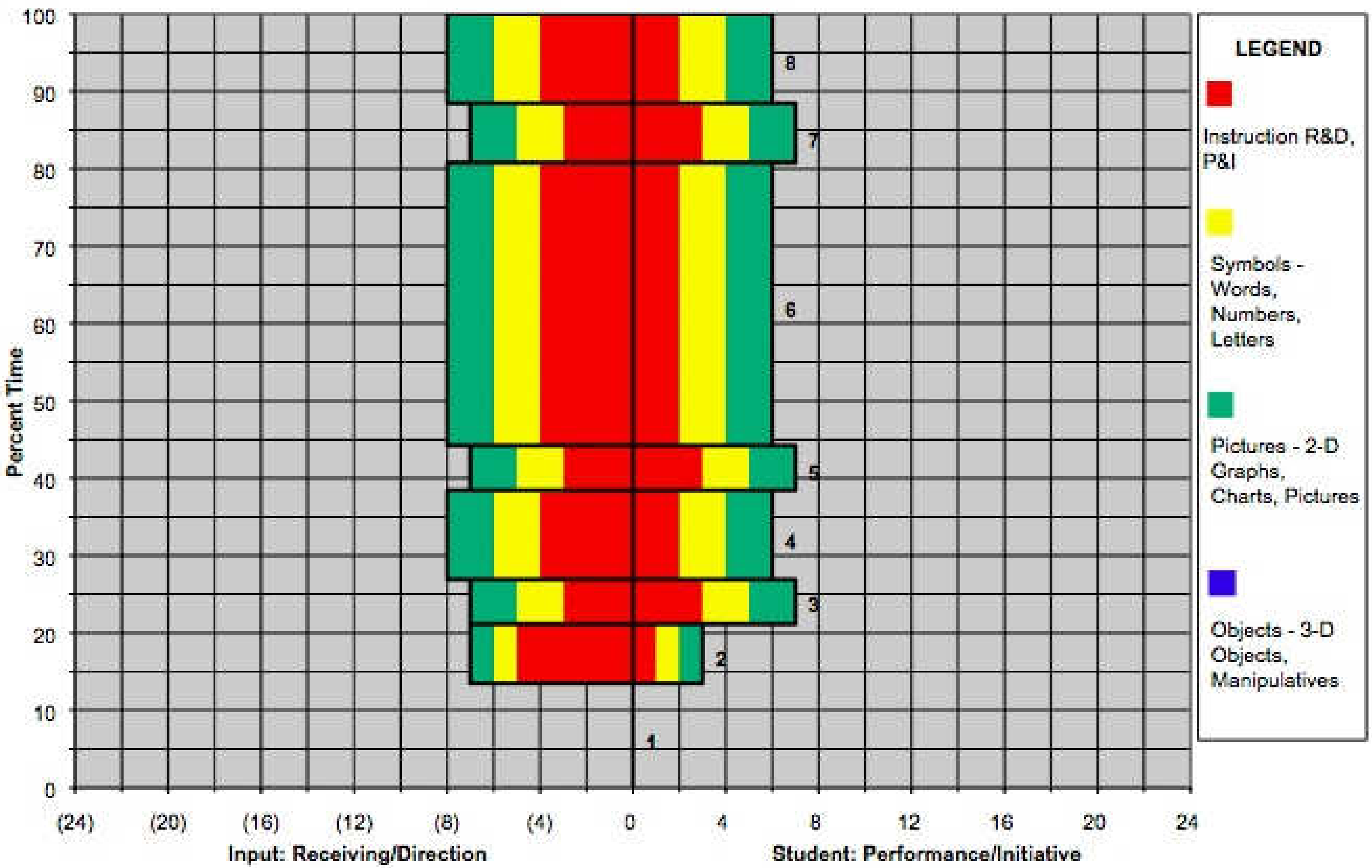

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Figure 3: M-SCOPS Profile from the initial observation of Beverly Magness' class

Deborah Samford – TPS Case #2

At the time of this study, Deborah taught integrated science to freshman at a public high school where 77% of students were minority and 62% were considered economically disadvantaged. It was Deborah's first year teaching. She had been a paralegal before she spent one year in a graduate level licensed alternative masters program at a local university and started teaching at her current school fall 2009. The class I observed was made up of approximately 12 African American students and about half were female.

Observation Description

Students were noisy and rowdy as they entered Deborah's classroom. They talked and joked with one another as school-wide announcements were made over the intercom. After the announcements Deborah had to ask several times before students settled down enough for her to begin class (segment 1).

Class began with a discussion of the activity students had done the day before. From the discussion I gleaned that students had been given pieces of thermochromic paper, which reacts to heat much like a mood ring, and had tested it on various substances and recorded the color it turned. Deborah asked students to tell her what substances they had tested and the color the paper had turned when it came in contact with them. She projected a copy of the worksheet they had been given on the SMART Board™ and recorded their answer on it (segment 2). While some students responded, the majority were off task. After a few minutes she stopped class to escort one particularly disruptive student out into the hallway as punishment (segment 3). When she returned she asked students to tell her which color they thought represented the coldest and warmest temperatures based on the examples students had given. A few students reluctantly answered while the majority continued to misbehave (segment 4). The student that had been asked to sit in the hallway returned to class a few minutes before Deborah escorted a second student out of the class (segment 5).

When Deborah returned to class, she showed students heat colored pictures of a person's hand before and after smoking a cigarette. She challenged students with the question "what's going on here?" A few students seemed intrigued and commented on the picture, but the majority kept on talking, singing, and dancing (segment 6).

After a few comments about the picture, Deborah passed out pieces of tinted film and told students to walk around the classroom and look at different things through them (segment 7). Students moved about the class, looking at objects in and outside the classroom. Several students "accidentally" dropped their film out of the open windows and asked for additional pieces. Deborah reluctantly gave them new pieces stating that she wouldn't have enough for other classes if they lost these. After a few minutes she handed a second piece of film to each student along with small transparent pictures that had different colors on them. Over the classroom din she asked students if they could discover the "trick" of the film. The "trick" turned out to be that the film was polarized and, if one piece was held level while the other was rotated, different colors would be highlighted or, in one position, nothing would be seen through them. After students had investigated the film for about 20 minutes, Deborah asked them to return their film pieces and complete their lab sheets (segment 8). She reminded them that they had to hand the sheets in for a grade and not to forget to put their names on them. Some students followed her directions, but the majority continued talking and joking with one another. A few minutes before the bell almost all of Deborah's students were standing around the door waiting to leave (segment 9). She asked them several times to stay away form the door, but her words had little effect.

M-SCOPS Analysis

The M-SCOPS Profile that represents Deborah's lesson can be found in Figure 4. This 52-minute lesson consisted of nine segments. There were significant classroom management issues and segments 1, 3, 5, and 9, which constituted 13 minutes or 24% of class time was intentionally left blank to show that all students were off task during these times. These segments were not calculated into percentages discussed in this analysis as "instructional time." Four of the five instructional segments of class time were spent in teacher-directed instruction at a level "5/1." During the remaining segment of instruction students manipulated polarized film as they walked around the classroom more or less in small groups at a level "3/3." During all instructional segments students focused on lower level skills while engaging in activities of telling, labeling, manipulating and examining. These actions provided little opportunity for sense making and there were few connections to content made. Class ended with students socializing at the door with little opportunity for closure or reflection.

ITC COP Analysis

After class was over I conducted a post-observation interview with Deborah, during which I asked to see the paper and the film the students had worked with during the two activities. Deborah enthusiastically showed me an optics kit she had received from a professional organization. The kit contained materials and activities to engage students in learning about waves and lenses. It took Deborah several minutes to explain what the learning goals of her lesson had been. Deborah thought that the activities helped students understand the properties of waves. The paper had turned colors according to the frequency of the heat waves being emitted from the substance and the polarized film blocked waves coming from a horizontal or vertical direction depending on which way it was held. I had not heard Deborah make an explicit connection to waves during a discussion of either activity and so it appeared to me that her lesson was more focused on the doing of the activity, rather than students thinking about it and using it to connect concepts.

<u>Design Score: 2</u>

Elements of investigative science could be seen in the design of Deborah's lesson. The lack of a clear learning goal and large amount of disruptive student behavior prevented this lesson from reaching whatever potential it may have had. Because these issues obscured the lesson's underlying design it was difficult to assess on this scale without considering others. For example, the behavior management issues that were observed could have been caused by and/or contributed to a poor design or the class may have had a solid design that was obscured by students' behavior. Whatever the reason, the class did not appear to be an effective learning environment for the majority of students.

Implementation Score: 1

Significant classroom management issues and the lack of a clear learning goal were evident in this lesson's implementation. While elements of investigative science could be seen, students' activities did not reflect a scientific investigation. Disruptive student behavior prevented the teacher from maintaining an appropriate pace, reading the students' levels of understanding, or engaging in appropriate questioning strategies.

Science Content Score: 1

Again, classroom management issues and the lack of a clearly visible learning goal obscured the science content presented in this lesson. It was difficult to say if the content was significant and/or worthwhile or if it was appropriate for the developmental needs of the students since the majority of the class was off-task the entire time. Disruptive student behavior also precluded opportunities for science to be portrayed as dynamic, for connections to be made to other disciplines, or for students to make sense of ideas.

Classroom Culture Score: 1

Deborah's students were highly disruptive and disrespectful throughout the lesson. Students were difficult and reluctant to engage with the lesson's content in meaningful ways. The atmosphere of the class was not indicative of a working relationship between students and/or teacher.

Capsule Description: Level 1 – Ineffective Instruction: Avtivity for Activity's Sake

This lesson lacked a clear sense of purpose and a clear link to conceptual development. There was little evidence that the majority of students engaged with important ideas. Disruptive behavior compounded these issues, making it a struggle for Deborah to complete simple tasks, let alone the complex activities that form the basis of classroom investigative science.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.36	3.51	2.76	3.74	3.60

Even though Deborah's scores on the ITC COP were the lowest of the group, her responses to questions on the STEBI Outcome Expectancy scale had the highest average and her score on the Personal Beliefs scale had an above-expected average. These scores paint a picture of a teacher who is confident in her ability to provide effective instruction, believes that quality teaching can positively impact student science achievement, yet has little experience or expertise in enacting instruction that aligns with these beliefs. It is interesting that Deborah, the teacher with the fewest years of experience teaching, is the one held the strongest beliefs about the impact effective teaching can have on student science achievement. Deborah's responses on the Leadership scales ranked her in the top third for level of leadership responsibility, above the group mean for confidence in her leadership abilities, and again in the top third in her belief that she had the knowledge and skills to effectively perform the activities associated with the LEADERS Project.

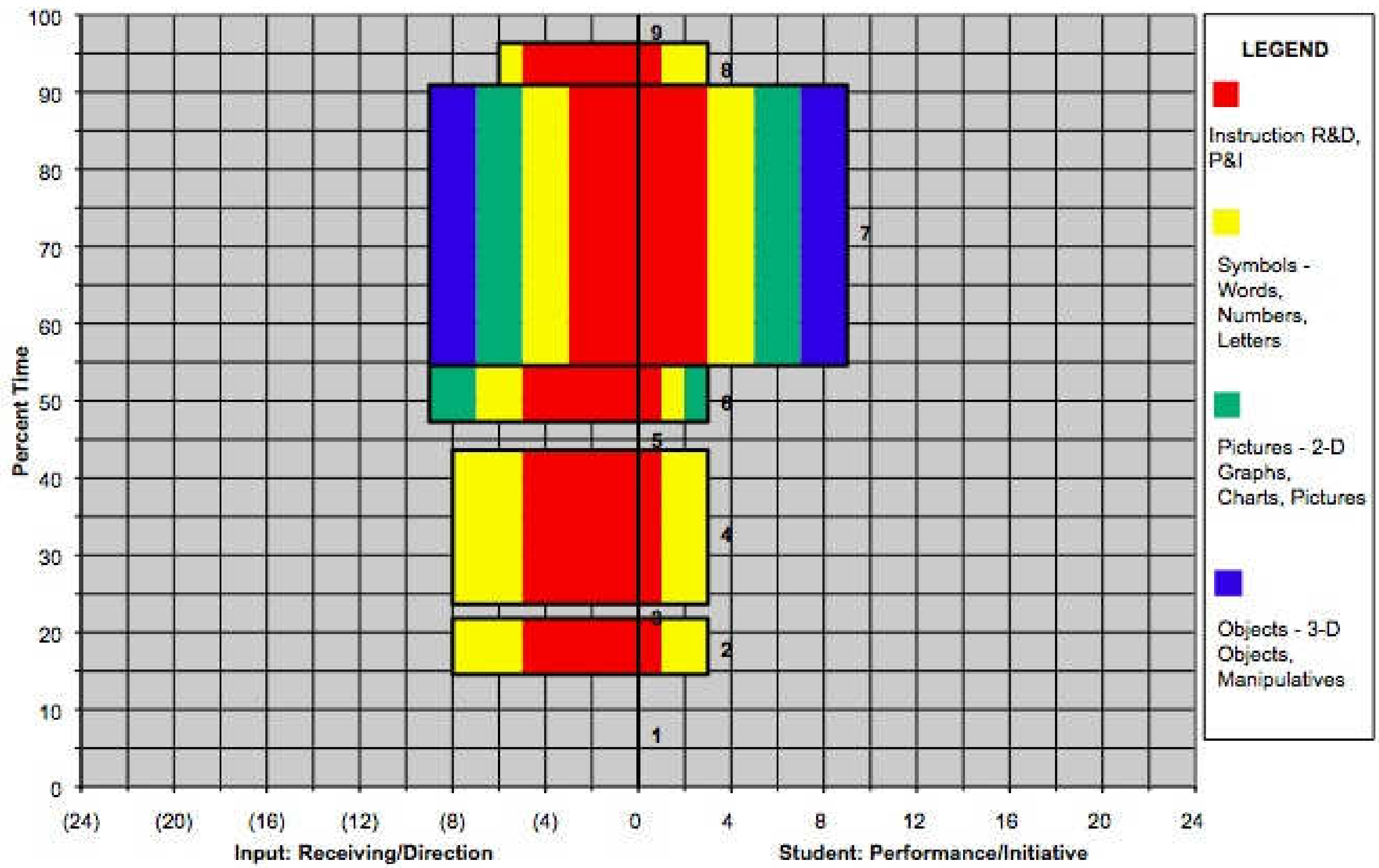

Figure 4: M-SCOPS Profile from the initial observation of Deborah Samford's class

Mary Rhode – TPS Case #3

At the time of this observation Mary was a 6th grade teacher at a K-6 public elementary school where 32% of students were minority and 40% were considered economically disadvantaged. This was Mary's thirteenth year teaching and third year teaching at her current school. Mary was responsible for teaching math and science content to two groups of students. Another teacher had the responsibility of teaching English and Social Studies content to the same groups of students. The observed class included approximately 20 students about half of which were African American and half White. About half the students were female. At the end of the 2010 school year Mary's school had been reassigned as a K-5 school and Mary was unsure which building she would be teaching in at the beginning of the 2011 school year.

Observation Description

As I entered Mary's room I caught the end of a math lesson. There was a short break while students moved their desks into groups of 4-5 for the science portion of their day. While Mary set up the materials for the lesson, she distributed tanks of tadpoles and butterflies to a few of the groups so the students could check on them and report on the changes they observed (segment 1). Students eagerly clustered around the tanks and cages and Mary visited the groups and briefly discussed their observations before beginning the lesson.

Mary told her students that during the lesson they would be investigating earthworm behavior. She reminded students about what they had learned about the characteristics of living things, handed out lab sheets, and briefly went over the materials and procedures that would be part of their investigation (segment 2). She asked students to write their hypotheses while she began to distribute materials (segment 3).

The experiment would test whether earthworms preferred a wet or dry substrate. Moistened paper towels would line half a tray and dry ones would line the other half. The earthworms would be placed in the center and the tray would be covered for a few minutes. After it had been covered for a while, students would observe where the worms moved. Mary gave a few worms to each group while students began wetting paper towels to set up the experiment (segment 4). Once all the groups had their worms, they began their experiment (segment 5). During this time, Mary monitored the class, asked groups a few questions, and gave some advice on procedures. Another butterfly emerged about half way through this segment and Mary carried the cage around so students could see it before its wings were fully dry. About twenty minutes later Mary briefly called students' attention to a few of the questions they should be trying to answer. She asked them to figure out which was the worm's front end and what kind of symmetry a worm had (segment 6). Students listened quietly as she spoke and then quickly went back to work. Students were given another fifteen minutes to work (segment 7) before Mary asked them about another possible experiment: whether earthworms would prefer rough or smooth surfaces (segment 8). She asked what they thought the worms would prefer, why they thought their ideas would be right, and how they might test their ideas. She told them that she had brought some sand paper and asked them to discuss possible designs with their groups. Students quickly came up with an experiment similar to the wet/dry one they were doing, that they could do with rough/smooth surfaces.

Mary told the class they would have about five minutes to finish up their experiment before it would be time to clean up and head to lunch. Students worked diligently during these final minutes (segment 9) and quickly cleaned up, washed their hands and lined up at the door when they were asked to do so.

M-SCOPS Analysis

The M-SCOPS Profile that represents Mary's lesson can be found in Figure 5. This 57-minute lesson consisted of nine segments. Students spent 81% of class time at a level "3/3" in small groups observing metamorphosis and working on their experiments. For the remainder of class, 7% of time was spent discussing the design of a new experiment at a level "4/2" and 19% was spent at a level "5/1." Students were engaged in hands on activities that involved 3D representations for 96% of class time; however, they were focused at IS levels 1-3 for 98% of class. This high level of focus on low-level skills reinforced the observation that there were few explicit opportunities for students to reflect upon, synthesize, or connect what they were doing to prior knowledge or content.

ITC COP Analysis

<u>Design Score: 3</u>

This lesson was an investigation of earthworm structure and behavior. The design incorporated tasks, roles and interactions aligned with investigative science. Students worked in small groups to conduct the investigation, which seemed well within their abilities to do. There was very little time dedicated to "sense-making." Most of class time was focused on doing the experiment. Students went directly from experimenting, to clean up, and to lunch. There was no formal wrap up and Emily's comments during the post-observation interview indicated that they would move on to a new topic the next class.

<u>Implementation Score: 3</u>

Students were well behaved and on task for the majority of this lesson, which showed that Mary's classroom management strategies were effective. Students were engaged in an investigation, but their activities focused much more on doing than understanding what they were doing or why. Students' discussions and Mary's questions were surface level and reinforced this focus. Therefore, the lesson in practice was not highly aligned with the ideas about investigative science that it could have been.

Science Content Score: 2

In this lesson science content took a back seat to setting up and conducting an experiment. Students mainly focused on procedures and surface level ideas. There were few opportunities for students to connect ideas to one another, to experiences outside of the classroom context, or to other areas of math or science. There was also very little time set aside for sense making.

Classroom Culture Score: 3

The atmosphere in Mary's class was collegial and respectful. Students worked in groups well and were on task the majority of the class. The surface-level focus of the content and procedures coupled with the limited amount of time spent sense making, prevented many of the rich conversations and activities, such as constructive criticism and idea challenging that are important parts of authentic scientific investigations, from taking place.

Capsule Description: Solid 3 – Beginning Stages of Effective Instruction

This lesson's design had the potential to be more aligned with investigative science, yet there were weaknesses in its implementation. The surface-level and procedural focus of student activities prevented higher-order discussions from taking place. This also limited the lesson's potential for enhancing students understanding of biology or scientific processes. However, the lesson was purposeful and students were at times engaged with meaningful work. For these reasons this lesson was assigned a capsule rating of a solid three on the ITC COP.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.68	3.30	2.87	3.20	2.77

Mary's responses to both STEBI scales placed her in the top third of the teacher leaders. Based upon her scores, she believed she had the ability to provide effective instruction that could make a difference in students' science achievement (albeit not a great deal of difference). Her responses to the Leadership survey indicated she had the greatest amount of leadership responsibility but ranked in the bottom third for both confidence and perceived knowledge and skills with regards to activities that would make up a large part of her responsibility as a teacher leader.

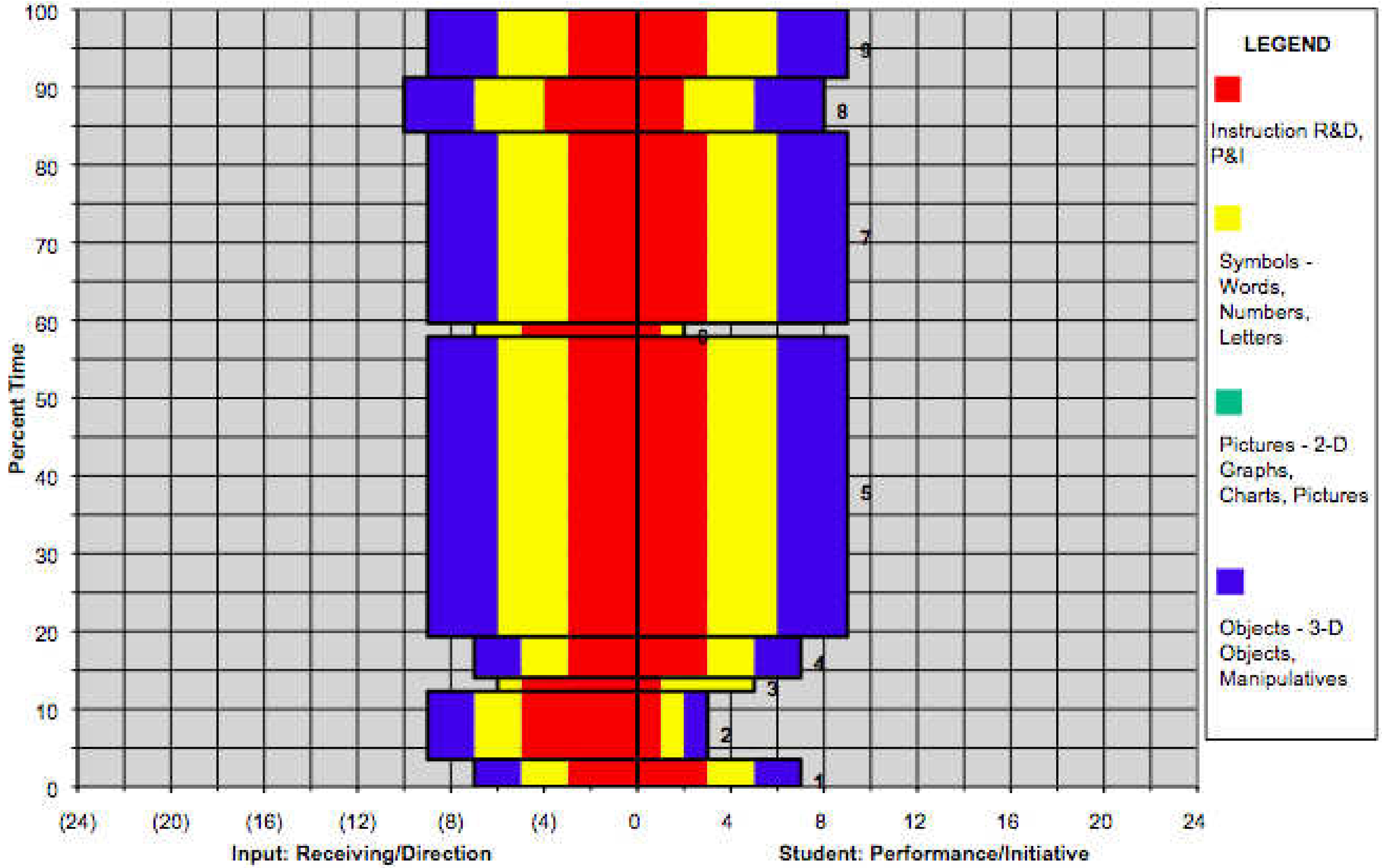

Figure 5: M-SCOPS Profile from the initial observation of Mary Rhode’s class

Irene Hobart – TPS Case #4

At the time of this observation Irene was a high school teacher at a public high school where 77% of students were minority and 62% considered economically disadvantaged. She had been a teacher for eight years in total and had taught at her current school for four of those years. I observed her first period class: 9th grade physical science. She invited me to watch her students launch rockets out on the football field as they conducted an investigation of rocket flight and design. Due to poor weather conditions she had to change her plans and, instead, students investigated the big bang theory by using balloons to model the expansion of our universe.

Observation Description

Irene had Star Wars music playing in the background as students entered their first period class. They took their seats and began copying definitions off the board while the rest of the students arrived and got settled (segment 1). To frame the lesson, Irene led a brief discussion with her students focused on questions such as: How did the universe begin? Were scientists there? How did they find out what they know if they weren't? (segment 2). This discussion led into an explanation of the procedures that would be part of that days' investigation on the big bang theory (segment 3). Students would draw several dots on a deflated balloon and then slowly blow the balloon up a bit at a time. Students would measure the distance between the dots they had drawn as they gradually increased the balloon's size.

She asked students what they thought would happen, would the dots get closer or farther? Would they move at the same rate or at different rates? (segment 4). After a few minutes of sparse responses she asked students to discuss their ideas with a neighbor (segment 5). She remarked after a minute that she still did not hear any discussion and brought the class together to complete the discussion as a whole (segment 6).

Once a few ideas had been voiced and the class had more or less agreed on a prediction, Irene asked her students to get in their groups and get to work. After about 15 minutes of monitoring their group work, Irene began to visit the groups and question them about their findings. She noted that some groups had placed their dots evenly around the top of the balloon and had not recorded data that would help them see the patterns that led to an understanding of the big bang theory and she asked those groups to share their data and compare their results with other groups. During her visit to each group she discussed with students how their data compared to what scientists had found about the universe, connecting their investigation to content (segment 7).

As students finished discussing their results with other groups and trickled back into their seats, Irene asked them to finish writing up their data and conclusions on the sheet she had provided. Most students worked on this until the bell (segment 8).

M-SCOPS Analysis

The M-SCOPS Profile that represents Irene's lesson can be found in Figure 6. This 52-minute lesson consisted of eight segments. Class began with a series of segments that alternated between teacher-directed instruction and teacher-led discussion before students broke into small groups to conduct an investigation. Students were engaged at an instructional level of "5/1" for 32% of class time, a level of "4/2" for 15%, and a level of 3/3 for 53%. Students manipulated 3D objects for 55% of class time. Students were focused on copying information at the beginning of class and listening to the procedures for the experiment, both low-level 1 activities, for 21% of class. For the remaining 79% of class time, students were engaged in higher-level 4 and 5 activities as they connected ideas and transformed data. Irene visited groups individually during segment 7 to help them reflect upon, synthesize, and connect their understanding of the experiment to ideas about the big bang theory and other areas of science.

ITC COP Analysis

Design Score: 5

This lesson appeared well designed and streamlined to fit within the 52-minute periods at Irene's school. Materials were provided in a way that minimized the time students spent preparing for the experiment and maximized the time they spent collecting and thinking about data. Irene spent very little time in a direct instruction mode, allowing students to engage with the content in the hands-on and minds-on ways that are characteristic of investigative science. She visited with each group and probed their understanding of the lab while she made connections to content explicit to ensure student understanding.

Implementation Score: 4

Irene's lesson implementation was consistent with investigative science. The lesson appeared to engage students with content and hold their attention for the majority of the class. The teacher visited each group of students individually, probing their understanding and making connections to content explicit, strategies that appeared would enhance students understanding of science and the big bang theory. Students were reluctant to engage in discussion, and Irene attempted to use several instructional strategies to address this, indicating that she was "reading" the level of student understanding and interest.

Science Content Score: 4

Student understanding of the big bang theory and the methods scientists' had used to investigate it were the focus of this lesson. Students were engaged in seeing first hand that the dots they had drawn on the balloon to represent planets did not always get further away nor get further away from each other at the same rate. Irene individualized her instruction to the small student groups, providing her with the ability to better probe student understanding and to help them make connections to content explicit and integrated with students' own ideas.

Classroom Culture Score: 4

The atmosphere in Irene's class was respectful. Students worked well together and were generally on-task and well behaved. Students were encouraged to provide ideas, questions, conjectures and propositions, but were reluctant to do so. The reasons behind this reluctance did not appear to be because of the class itself, but because of the time of day and the disappointment of being indoors when they had hoped to be out shooting rockets. Whatever the cause, this reluctance did appear to stifle students' ability to generate fodder for higher order activities, such as constructively challenging and criticizing each other's ideas.

Capsule Description: Level 4 – Accomplished Effective Instruction

This lesson was well aligned with investigative science. The design was well thought out and aligned with investigative science within the constraints of the school day. Implementation was adaptive to students' inclinations and ideas. Connections to content were individualized and explicit. This lesson appeared quite likely to enhance students' understanding of the big bang theory and their capacity to "do" science and was therefore assigned a Capsule rating of four.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.45	2.47	2.66	3.84	3.40

It was interesting to compare the results of Irene's observation with her STEBI responses. Through observation Irene appeared to be an effective teacher who competently implemented an investigative science lesson. While her score on the Personal Belief scale placed her at about the group average, surprisingly her score on the STEBI Outcome Expectancy scale was the lowest of all the teacher leaders and below the expected average (and therefore a negative expectation). Her responses to the leadership survey indicated that, before the LEADERS Summer Institute, she had some leadership responsibility and a moderate level of confidence in her ability to carry them out. She also reported a moderate level of the knowledge and skills necessary to enact the activities associated with the LEADERS Project.

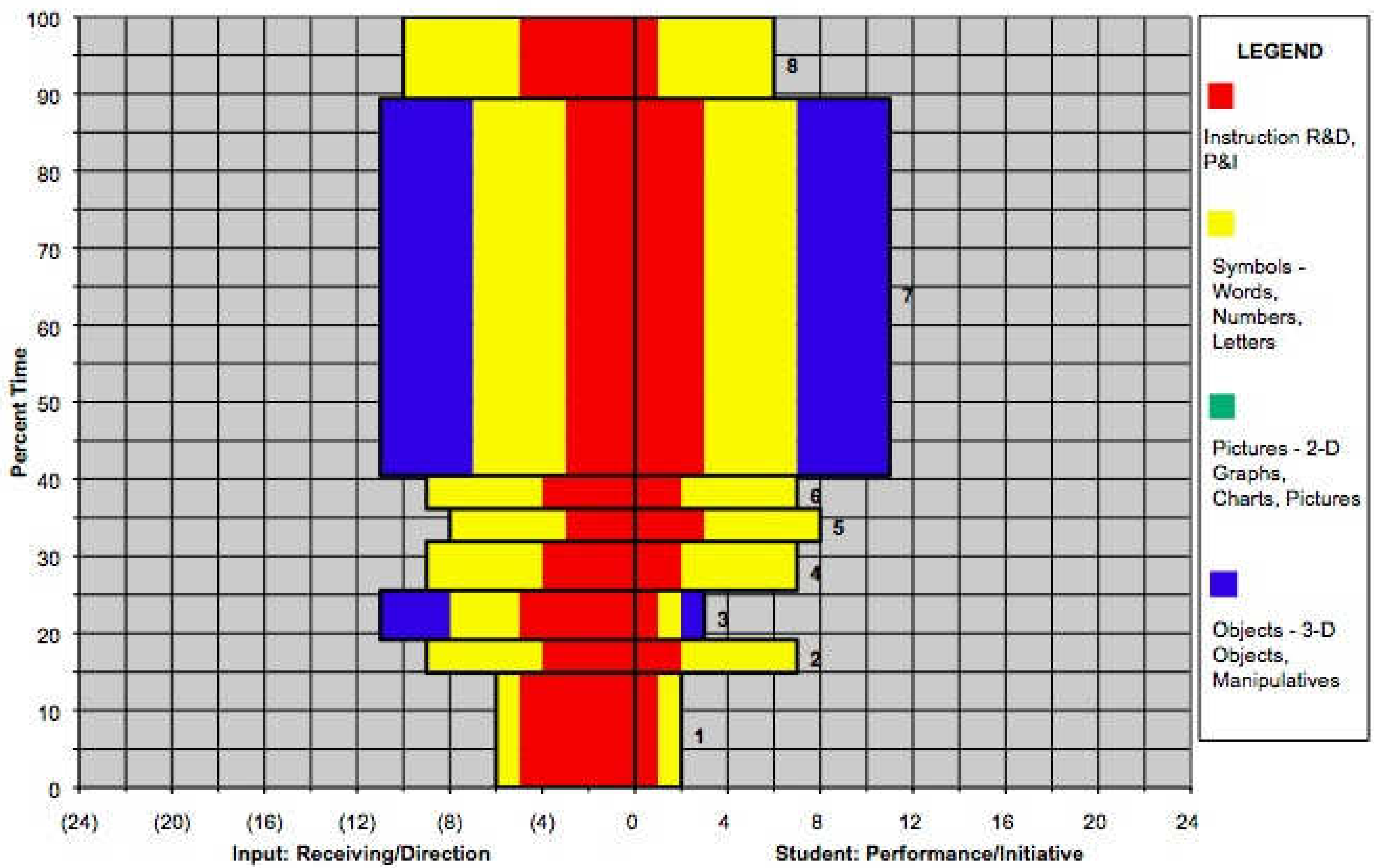

Figure 6: M-SCOPS Profile from the initial observation of Irene Hobart's class

Travis Wright – TPS Case #5

At the time of this observation, Travis was a high school teacher at a magnate high school with a focus on manufacturing engineering. Thirty-five percent of students at Travis' school were minority and 39% were considered economically disadvantaged. This school used a project-based approach to prepare students for science-related careers using technology, science, and engineering. During their freshman year, students were engaged in a number of team building activities. The skills learned through these activities formed the base of the skills they would use in all their classes to complete various projects over the rest of their high school career. Travis had been the physics and chemistry instructor for all of his 21 years teaching and employed at his current school since its inception in 1993.

Observation Description

The day I observed his class, Travis' students were in the middle of a project to design a car powered by a hydrogen fuel cell. Students were challenged to build the fastest car possible using whatever materials they had available or could bring in from home. Earlier, they were introduced to the way a two-canister hydrogen fuel cell worked and Travis further challenged them to think about how they might be able to use a single canister to power their car, thus reducing the car's weight and increasing its speed.

Travis began class with a brief review of where they were and reminded students of the goals of the car design challenge (segment 1). During this time he entertained a few questions about the rules of the challenge and the deadline for having a completed car. Travis had a flexible view on the deadline and told his students it would be one of the next two classes, depending on how well they were working and how far along their designs got. Once all questions were answered, Travis told students they would have the rest of the class to work in their groups on their cars (segment 2). As students worked Travis walked around to view their progress and pushed their thinking further with questions that encouraged students to think about their designs differently.

M-SCOPS Analysis

The M-SCOPS Profile that represents Travis' lesson can be found in Figure 7. This 69-minute lesson consisted of two segments. During the first segment, which spanned 6% of class time, Travis went over guidelines fort the challenge that students would spend the rest of the class working on. He directed this segment at an instructional level of "5/1" while students passively listened at the low IS level of 1. For the remaining 94% of class, students worked in independent small groups with little teacher direction to design their cars. This activity fell into the instructional category of "1/5" and engaged students in high level 5 skills as they generated solutions to the complex problems involved in the challenge they were presented. Throughout the entire class students focused on 2D representations and manipulated 3D objects. There was no explicit opportunity for reflection, synthesis, or connections among ideas to be made, but based on responses to post-observation interview questions; it is likely that opportunities for these types of activities would arise at the conclusion of the challenge.

ITC COP Analysis

This lesson was part of a longer investigation that was highly student-directed and open-ended. Without seeing other lessons that may have framed and/or connected the content that drove students work, judging this lesson on the scales of the ITC COP was challenging. To get a better idea of these issues I include comments from my post-observation interview with Travis to support the making my judgments about his lesson.

Design Score: 4

Students spent the class in groups of four to five designing what they thought would be the fastest fuel cell powered model car. This design definitely encouraged a collaborative approach to learning. During the post-observation interview Travis discussed some of the content he had covered leading up to the lesson and how challenges like this were a normal part of the school's curriculum. Because of this I believed that these instructional strategies paid attention to students prior experiences and addressed issues of equity. Due to the placement of this lesson, there was little time wrapping up or making sense of content, but since the lesson was part of a longer sequence, I found it safe to assume that these activities would come later. Because of the difficulties of judging this lesson paired with the high level of alignment of this lesson with the tenets of reform-based instruction inherent in the ITC COP, this lesson's score was thought to be conservative.

Implementation Score 4

The activities in which students engaged in during this lesson were highly aligned with investigative science; the teacher was confident and tailored instructional and questioning strategies to students as he visited with their groups. Many students held off-topic conversations as they worked on their cars, which seemed reasonable given the nature of their work (i.e. building a car interspersed with ideas about how it should be built).

Science Content Score: 4

No content was presented formally during this lesson. The questions Travis asked as he visited groups appeared to further students understanding of the subject and provide accurate information. Additionally, Travis' responses to the post-observation interview questions indicated there had been a few days prior to this lesson focused on understanding the chemistry and physics of fuel cells. With this in mind, the content of this lesson seemed appropriate and worthwhile. Furthermore the task students were engaged with was authentic and encouraged them to engage with the content in ways that were highly aligned with the work of scientists or other industry professionals.

Classroom Culture Score: 4

Students were busy working in groups, talking to each other about their car design, and building their car. Travis visited groups and asked them questions and offered suggestions as he went. These activities were representative of working relationships between teacher and students and also provided opportunities for students to generate critique and challenge each other's ideas. Many students had off-task conversations which again appeared to be due to the nature of the work. Because the outcome of the lesson was not viewed, gauging the success of these activities is difficult.

Capsule Description: Level 4 – Accomplished Effective Instruction

This lesson appeared to be a compelling example of investigative science, although without seeing the entire sequence, the effectiveness of this particular lesson is difficult to gauge. In my view this lesson could have easily been a five, yet without seeing the results first hand this lesson was assigned a conservative overall score of four on the ITC COP.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.07	3.38	2.59	2.99	3.75

Although Travis' teaching appeared effective during his observation, his responses to the STEBI Personal Belief scale indicated a fairly neutral belief that he was an effective science teacher. His responses to the Outcome Expectancy scale indicated an only slightly higher level of belief that effective science instruction can have a high level of impact on student science achievement. Like the majority of the other teacher leaders, Travis indicated that he had a moderate level of leadership responsibility. His responses to questions about his confidence to carry out leadership activities on the Leadership survey were neutral. However, his responses to items about his knowledge and skills with regard to activities involved in being a teacher leader were the highest of the group.

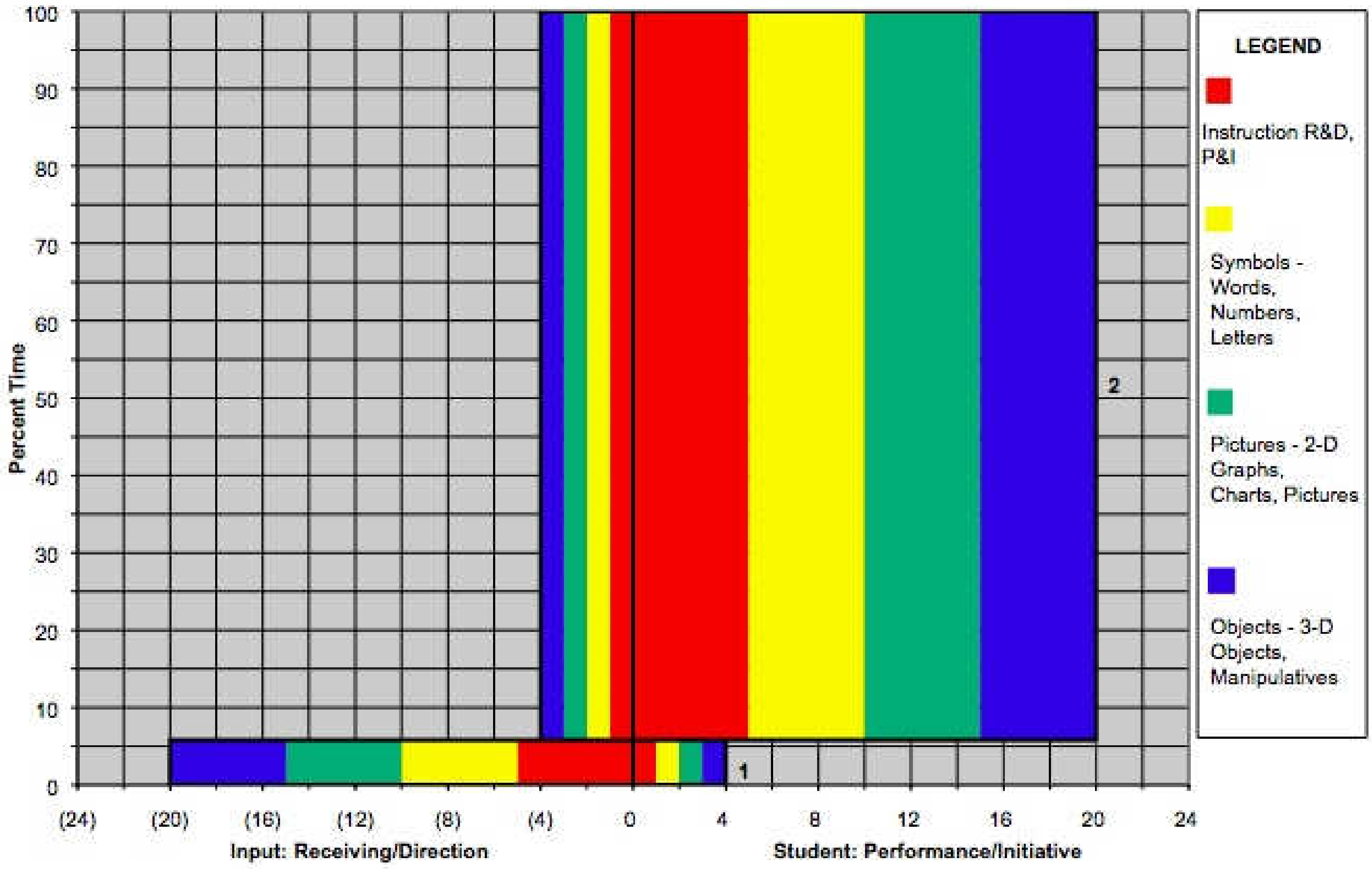

Figure 7: M-SCOPS Profile from the initial observation of Travis Wright's class

Sheri Jacobs– TPS Case #6

At the time of this study Sheri was a 4th grade teacher at a public elementary school where 83% of students were minority and 94% were considered economically disadvantaged. She spent the last four of her ten years as a teacher at her current school. During our post-observation interview she discussed her work as a child advocate and mentioned that several of her students' home lives were less than ideal. Several had attendance issues and were rarely in school, one was woken up at 3 AM every morning so he could be dropped off at his father's house on his mother's way to work, and another was largely responsible for household tasks such as laundry and meal preparation for his four younger siblings. She told me that there were approximately 20 students in her class although only 14 were present that day. All were African American except for one White student and about half were female.

Sheri's class was just leaving an impromptu dance activity in the school gym when I arrived at her school. Her classroom was in a trailer behind the school building and I walked with them to it. Her students were talkative and friendly and eagerly inquired about why I was there and if they could show me some of the things they had in their classroom.

Observation Description

When we entered Sheri's classroom students headed to their desks. She began class by asking students to tell her what they had been learning about ecosystems. She listened to several of the ideas that were eagerly offered (segment 1) and then asked to look over page 101 in their book and name some big things about ecosystems and communities. This led into a discussion of populations and components of ecosystems (segment 2). Next Sheri gave students a few minutes to individually write down a few examples of living and non-living things (segment 3). She then asked students to read their entries aloud and record them on a large sheet of paper that was hanging on the wall (segment 4). After each student had contributed an example, Sheri turned their attention to an experiment they had been conducting with two potted plants on the back windowsill. She asked students to recall what the experiment was about. Students responded that one of the plants was being watered and the other was not. Sheri led a discussion about what effect students thought the treatment would have and what affect thought different levels of water would have on different ecosystem (segment 5).

After this discussion, Sheri handed out papers with words and pictures to illustrate the terms biotic, abiotic, and diversity. She led a short discussion about the meanings of the words (segment 6). She then asked several students to read aloud a few paragraphs from the book that related to the three words and briefly discussed the meaning of the passages (segment 7). During the final class segment Sheri used a SMART Board™ activity. Several elements of ecosystems were listed in bubbles next to a picture of a jungle. Students individually went up to the board to drag a word to the corresponding part of the picture. When a match was made, the computer read an informative statement about that ecosystem element (segment 8). This activity concluded class and it was time for the students who needed to take the bus to head to the parking lot. The rest of the students stayed in the classroom and chatted with each other and the teacher in a friendly way.

M-SCOPS Analysis

The M-SCOPS Profile that represents Sheri's lesson can be found in Figure 8. This 48-minute lesson consisted of eight segments that more-or-less alternated between episodes of teacher-directed instruction and teacher-led discussion. Instruction was at a level of "5/1" for 65% of class time and a level "4/2" for the remaining 35%. Students engaged with 2D representations for 38% of class time and 3D representations for 27%. Students were focused on low IS levels of 1 and 2 for 71% of class. There were however, two segments where students grouped and compared their ideas, an IS level of 3, and extended their understanding and explained relationships among ideas, an IS level of 5, which respectively occupied 13% and 17% of class time. This lesson utilized a variety of activities and provided multiple opportunities for students to make sense of and connect ideas to their prior knowledge and experience.

ITC COP Analysis

Design Score: 4

This lesson incorporated a variety of short activities that reflected careful planning and an understanding of student needs. There were multiple opportunities for students to draw on their prior experience and knowledge, to connect new learning to the real world, and to think about science concepts within the context of an investigation. Student collaboration was not a focus of this lesson and instruction was largely teacher-directed. The SMART Board™ activity nicely brought content from the day's lesson together and reinforced it.

Implementation Score: 3

The majority of students was well behaved, respectful, and engaged with content for the duration of the lesson. The lesson appeared developmentally appropriate and learning goals worthwhile. While some portions of the lesson were consistent with investigative science, other parts were not. Instruction was adjusted according to student understanding. Connections across disciplines were made but may not have emphasized higher order skills a great deal.

Science Content Score: 4

This lesson engaged students in learning about ecosystems at a developmentally appropriate level. Students were engaged with content for the duration of the class and multiple opportunities were available for them to make connections among ideas and with their prior knowledge. Some of these opportunities were within the context of an investigation. There was not a great deal of opportunity for students to engage in the processes of science with one another, but they did listen to and build on each other's ideas during teacher-led discussions.

Classroom Culture Score: 4

Students in Sheri's class were friendly and respectful toward one another and their teacher. All students were encouraged to participate in every activity. The teacher-directed discussion of the plant watering experiment provided an opportunity for students to engage in some of the thought processes central to investigative science. However, this discussion did not allow the opportunity for students to generate new ideas, make conjectures or challenge the ideas of others.

Capsule Description: Level 4 – Accomplished Effective Instruction

Sheri's lesson demonstrated purposeful instruction and an understanding of student learning styles. Most students were meaningfully engaged with science content throughout the lesson. This lesson was viewed as quite likely to enhance student's understanding of science and enhance their ability to "do" science as well.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.76	3.37	2.35	5.15	3.69

Like the majority of the teacher leaders, Sheri's STEBI scores indicated more confidence her ability to provide effective science instruction (personal beliefs) than her belief that her instruction would have a large impact on student's science achievement (outcome expectancy). Her responses to the Leadership survey indicated the lowest level of leadership responsibility of the teacher leaders and below the expected average score of 2.5. However, her responses to the items on the confidence scale gave her the highest level of confidence of the group in her ability to carry out various leadership roles to the extent that she was an outlier on that scale. Her responses to items about knowledge and skills indicated that she felt she had a fair amount of knowledge and skills already to be an effective teacher leader although she acknowledged that there is still much to learn.

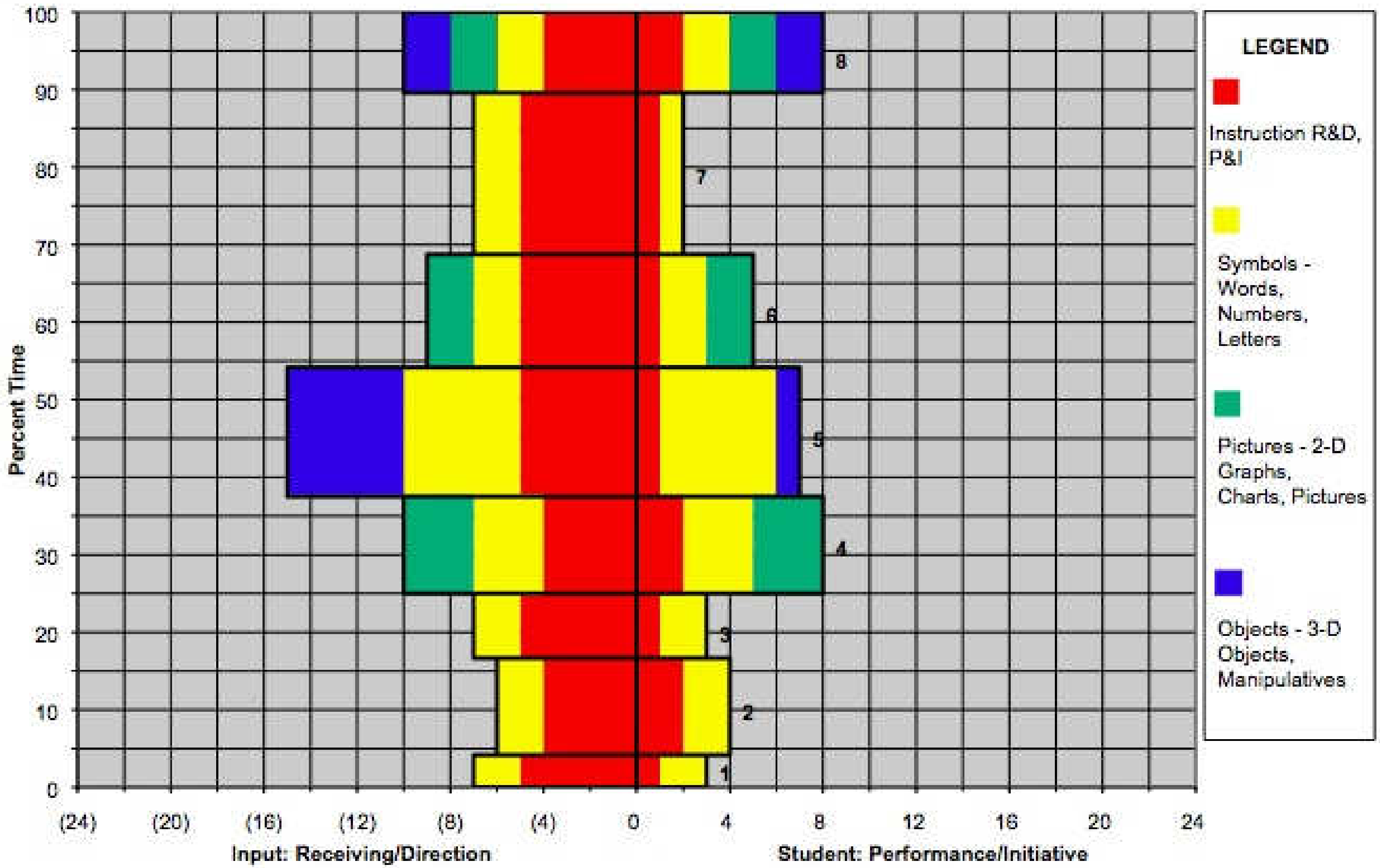

Figure 8: M-SCOPS Profile from the initial observation of Sheri Jacobs' class

2. Catholic Diocese of Toledo Schools

Amanda Emerson– Diocese Case #1

At the time of this study Amanda taught science to 5th through 8th grade students at a K-8 Catholic school that served a predominantly White and affluent population of students. Amanda had been a teacher for twelve years and had spent seven of those years at her current school. In addition to teaching science Amanda was the technology coordinator for her school. Amanda invited me to visit her 7th grade class. She was using a FOSS science kit as the basis for students to investigate how they could prove there was water vapor in the classroom air. There were approximately twenty students in the observed class. All were White except for one student of Asian descent.

Observation Description

Students trickled into Amanda's classroom, took their seats, and chatted with each other while waiting for class to begin. Amanda asked several times where a few of the students were and waited for them to arrive (about ten minutes) before beginning the lesson (segment 1). She began the lesson by asking students what they thought water vapor was. Students responded that it was a gas, and elaborated that it was the gas form of water (segment 2). This discussion continued with Amanda asking her students if they thought there was water vapor in the air of their classroom. Some student responded that there was and she asked them how they knew. Students were unable to answer how they could tell it was there, they stated that they just knew it was. She told her students that they would be challenged to come up with a way to prove there was water vapor in the classroom air. She showed them the materials they would have to work with: cups, ice, plastic bags, food coloring, paper towels, and anything else they wanted to use in the classroom. She told them that before they could get the materials to conduct their experiment they had to present a plan for what they wanted to do with the materials to her and justify why and how they thought their plan would work (segment 3).

Students worked in groups for about twenty minutes to come up with their plans (segment 4). While they worked, Amanda monitored them, listening to their conversations, helping the groups that were struggling, and listening to their plans as they completed them. Once a group presented her with an acceptable plan and justification, they were allowed to get the materials they needed and begin their experiment. After all groups' plans were approved, Amanda put the list of questions students would need to include in their presentation to the class and lab report up on the board and called students attention to them (segment 5). She told them they had about fifteen minutes before they would present to the class.

All groups had a similar experimental design. They had decided to put a few ice cubes in a cup filled with colored water and had either placed their cup on a paper towel or wiped it with a paper towel after several minutes, to show that the condensation that formed on the side was clear and had, therefore, come from the water vapor in the classroom air and not the colored water in the cup. Students worked diligently on the experiment and write-up until Amanda called for presentations to begin (segment 6). Amanda asked for a group to volunteer to start the presentations. Each group elected a spokesperson who stood up in turn and presented their experimental design, rationale, and results to the class (segment 7). Once all groups had presented, Amanda gave the word and the room was quickly cleaned (segment 8).

Once the classroom was clean, students returned to their seats and Amanda began a discussion about water vapor and their experiment (segment 9). She asked students how water vapor got into the air (boiling and evaporation), what had happened on the outside of their cups (condensation), and whether they could think of real world examples of these phase changes. Students were engaged and enthusiastic about the discussion. Soon it was time for the some of the students to leave to attend an algebra class. One they left, the other students were given the remainder of the class to work on their homework (segment 9). Students worked silently until the bell rang and then quickly placed their books on the back counter before they left for their next class.

M-SCOPS Analysis

This 75-minute lesson consisted of 10 segments. No formal instruction took place during the first and last segments of class time. During the first segment of class time (9 minutes or 12% of total class time) Amanda waited for late students to arrive. This segment was left blank to show that class time was not utilized to its fullest extent. During the last segment of class time (13 minutes or 17% of total class time) more than half of Amanda's students left for an Algebra lesson and the remaining students were given time to complete their homework assignment. These segments were not calculated into the percentages discussed in this analysis as instructional time.

Students spent the majority of the lesson (40% of total class time; 56% of instructional time) developing and conducting a scientific investigation in small groups to prove there was water vapor in the classroom air. During these activities students were engaged with content at an IS level of 6 or "generate," the highest level possible. There were teacher-directed discussions before and after this activity (segments 2 and 9; 16% of total class time; 23% of instructional time). These discussions engaged student's prior knowledge, connected classroom activities with out of class experiences, and encouraged students to make connections among important content-related ideas. These activities were at an IS complexity level of 5 or "connect." There were only three short segments of instructional time where students were not engaged in higher order thinking skills (segments 3, 7 and 8). These segments were 7 minutes in total time, representing 9% of total class time or 13% of instructional time.

ITC COP Analysis

Design Score: 5

This lesson appeared very well designed and incorporated a number of the tasks, roles, and interactions consistent with investigative science. Students worked in groups designing and conducting their experiments for 56% of instructional time. They were focused on higher-order tasks for 87% of instructional time. Amanda exhibited a high level of understanding of her students and her learning goals as she interacted with them as they designed and carried out their experiments. An in-depth discussion at the beginning and end of class engaged students prior knowledge and provided a good deal of time for them to make sense of the day's lesson and connect their in-class learning to out of class experience.

Implementation Score: 5

This lesson was a good example of investigative science. Students were well behaved and engaged in meaningful activity for the duration of the lesson. A few students seemed to be a bit overwhelmed with the open-endedness of the task but Amanda expertly addressed their worries and got them on track. Amanda's questioning strategies as she asked students to justify their plans to her and while they presented their plans encouraged conceptual understanding and core science process skills. Furthermore, during whole class discussions, she pushed students to make connections among science concepts and their lives outside of school.

Science Content Score: 5

The investigation involved in this lesson appeared to be a good way to open the door to students' understanding phases of matter--a significant idea in the physical sciences. The discussions and activities included in this lesson focused on the development of conceptual understanding. This focus provided multiple opportunities for students to abstract their ideas and make connections to their lives and experiences outside of school.

Classroom Culture Score: 5

Students in Amanda's class were well-behaved, on-task, and respectful of each other's ideas. They worked in groups on a scientific investigation for 56% of instructional time. By asking students to design and justify their ideas before allowing them to conduct their experiment, Amanda encouraged students to generate and share their ideas while developing questions, conjectures, and propositions--all interactions consistent with investigative science. These activities encouraged intellectual rigor, constructive criticism, and created a forum where students had opportunities to challenge each other's ideas.

Capsule Description: Level 5 – Exemplary Instruction

Overall Amanda’s lesson was well designed. Its implementation was highly consistent with investigative science. The discussions and activities in which students engaged were highly likely to develop conceptual understanding of the subject matter and enhance their ability to engage in scientific processes and discourse.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.85	3.02	2.76	3.56	3.40

In addition to her lesson’s high level of alignment with investigative science instruction, Amanda’s responses to the STEBI Personal Beliefs scale indicated she held one of the most positive beliefs about her ability to provide effective science instruction. Only one other teacher leader’s responses indicated more positive beliefs. Additionally, her Leadership Confidence scale score ranked her in the top third of the teacher leaders. However, her Outcome Expectancy score was just above the expected mean indicating that she may not strongly believe that effective instruction could bring about improvement in student science achievement. Prior to the start of the Summer Institute her responses indicated that she held a moderate leadership role in her district. She ranked in the top third of the group for current leadership responsibilities and felt she had many of the skills and knowledge needed to carry out her duties as a teacher leader.

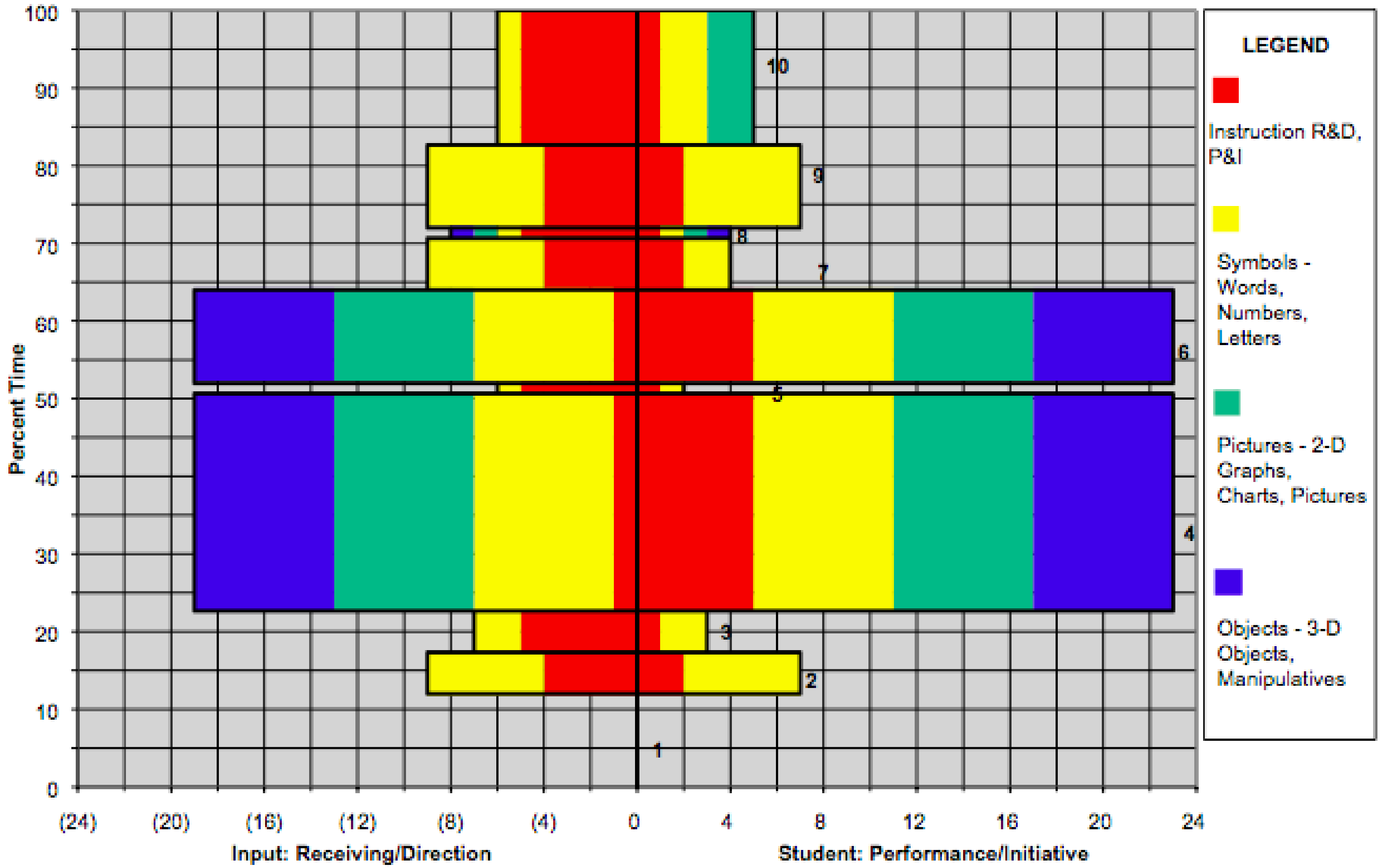

Figure 9: M-SCOPS Profile from the initial observation of Amanda Emerson's class

Rhonda Lipsey – Diocese Case #2

At the time of this study, Rhonda taught science to 6th through 8th grade students at a Catholic middle school. She had been a teacher for 25 years and taught 23 of those years at her current school. Rhonda had invited me to observe her 6th grade science class. There were approximately 14 students in her class. All were White and about half were female. I intended to visit Rhonda's class the previous day but had been delayed. Rhonda informed me that her class would be a bit shorter than usual, as her students would be coming to her class from Mass. She also stated that she held off on doing the lesson on technology that I observed since she thought it was a good representation of investigative science.

Observation Description

Rhonda's lesson that day was focused on connections between technology and society. Rhonda had the learning goals: describe how technology is tied to history, explain how technology affects people in both positive and negative ways, and explain the risks and benefits of products to help people make decisions about technology, written on the board. She also had written on the board that the goal of technology was: "to improve the way people live".

Mass ran about twenty minutes over. Students rushed into Rhonda's class and quickly took their seats. Rhonda began class by asking students to read the goals on the board out loud and recall what they had learned about technology in past classes (segment 1). She reminded them of the acronym ECO that they had discussed. The letters stood for: emerging, coexisting, and obsolete which were the three stages technology occupied in society. She then asked them to open their books to page 108 and review the lab activity they should have read for homework. For this lab students would be given an example of a technology and would make a list of 4-5 advantages and disadvantages of it. Rhonda asked student to take out a piece of paper and write the title of the lab at the top.

Students' desks were clustered in three groups. Rhonda handed a technology example to each. The examples were calculators, remote controls, and laptop computers. Students worked with their group to develop their list (segment 2). Only one group seemed to discuss their work; the other two worked more or less individually in silence. As they worked, Rhonda walked around and monitored her students. One student called her over to ask what the hypothesis for the lab should be. Rhonda responded that the hypothesis was that "students would find advantages and disadvantages of technology". Students were given about five minutes to work on their lists and then were asked to share. Each group reported their ideas quickly and with little discussion (segment 3).

Once all ideas had been shared, Rhonda asked her students to refer back to page 108 of their books. She asked several students to read the page out loud. After each paragraph had been read, she asked students to share the facts they had learned. Rhonda then asked students to turn to page 110 and "text to text", which I later learned meant they were to paraphrase what they read (segment 4).

As students worked, Rhonda passed out a worksheet. She explained that they were to work as groups and use the main ideas from the technology examples on pages 108-109 to fill in the positive and negative effects of the technology examples. The examples were airbags, pesticides, tractors, and computers. Students were given about three minutes to complete the worksheets (segment 5) and then Rhonda called on individual students to report the effects they had written down to the class. She provided a few extra comments about several of the effects (segment 6).

Once all the effects had been listed, students turned to page 115 in their books and were asked to read paragraphs out loud. After each paragraph was read she called on individual students to state the main ideas (segment 7). During the final segment of class time students were asked to reread and "text to text" the section in the book about the Internet as well as complete a guided reading packet (segment 8). Upon receiving the packet, one student commented that they had already read it. Rhonda responded that, yes, they had already read it but that this time they were reading it as a review.

M-SCOPS Analysis

The M-SCOPS Profile that represents Rhonda's lesson can be found in Figure 10. This 28-minute lesson consisted of eight segments. Instruction was predominantly teacher-directed with 57% of time being spent at a "5/1," 22% of time at a "4/2," and the remaining 21% of time being spent with students in small groups at a "3/3." Students spent the entirety of instruction doing tasks such as listening, reading, listing ideas and telling their ideas to the class. These lower level skills all fall into IS levels 1 and 2. 86% of class time focused solely on words and symbols. Examples of technologies were provided for students to manipulate for the remaining 14% of class time but students engaged with them at a surface level and they did not significantly enhance instruction. The class ended with no closure or opportunity for students to reflect on or synthesize what was learned.

ITC COP Analysis

Design Score: 2

This lesson was teacher-directed (79% of time was spent at a level "5/1" or "4/2") and focused on lower level skills (100% of the lesson was at an IS level of 1 or 2). The majority of class time was focused on reading and rewriting portions of the textbook. Few opportunities for students to connect their ideas to their prior knowledge or experiences were present and different learning styles were not addressed. While students were encouraged to work in groups, the lower-level skills involved in the activities they were given to do did not create a need for in-depth discussion. These characteristics were far removed from the vision of investigative science.

Implementation Score: 2

Again, this lesson was characterized by highly teacher-directed methods and predominantly lower-order questions and answers. Students discussed the pros and cons of different technologies at a surface level and much of this discussion came directly from the book. The teachers questioning patterns and the majority of student activities were focused on students repeating or rewording book passages. There was no observed opportunity for students to engage in activities characteristic of investigative science such as critiquing or challenging idea.

Science Content Score: 2

After class Rhonda told me that the learning goals she had written on the board had come directly from her school's curriculum standards. While these goals were complex and worthwhile, it is unlikely that the surface-level approach to content seen in this lesson accomplished them. The ideas about technology that were a focus of Rhonda's lesson often did not move beyond the information provided by the book. This approach did not portray science as a dynamic field. Rather, it leaned toward the view that the right answers were in the book. Students were obedient throughout the lesson but several comments made it seem as though the lesson was not challenging for them.

Classroom Culture Score: 2

While students in Rhonda's class were well behaved and respectful of each other, the activities they were given did not encourage them to have in-depth discussions. Most of the activities were teacher-directed and focused on information that came directly from the textbook. This left little opportunity for students to collaborate at below surface levels, which would have led to the types of discourse patterns, such as idea challenging and critique that are characteristic of investigative science.

Capsule Description: Level 2 – Elements of Effective Instruction

Overall this lesson appeared limited in its likelihood to enhance students' understanding of science as a dynamic discipline or in their capacity to "do" science. While students spent the majority of class focused on content, the reciting and rewriting activities in which they were asked to engage did not appear to foster conceptual understanding, connections among disciplines, or view of science as a dynamic field. The activities were surface level and left little opportunity for students to make conjectures or have the in-depth discussions that are characteristic of the definition of investigative science on which the ITC COP is based. Additionally, many students appeared underwhelmed with the content and pace of the lesson.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.18	3.09	2.59	3.56	3.45

Rhonda's STEBI scores revealed that she had both a moderate level of belief in her ability to teach science effectively and that these strategies would positively effect student learning. Her level of reported leadership responsibility, confidence, and knowledge and skills with regards to the activities that would be a large part of her role as a teacher leader, were also moderate.

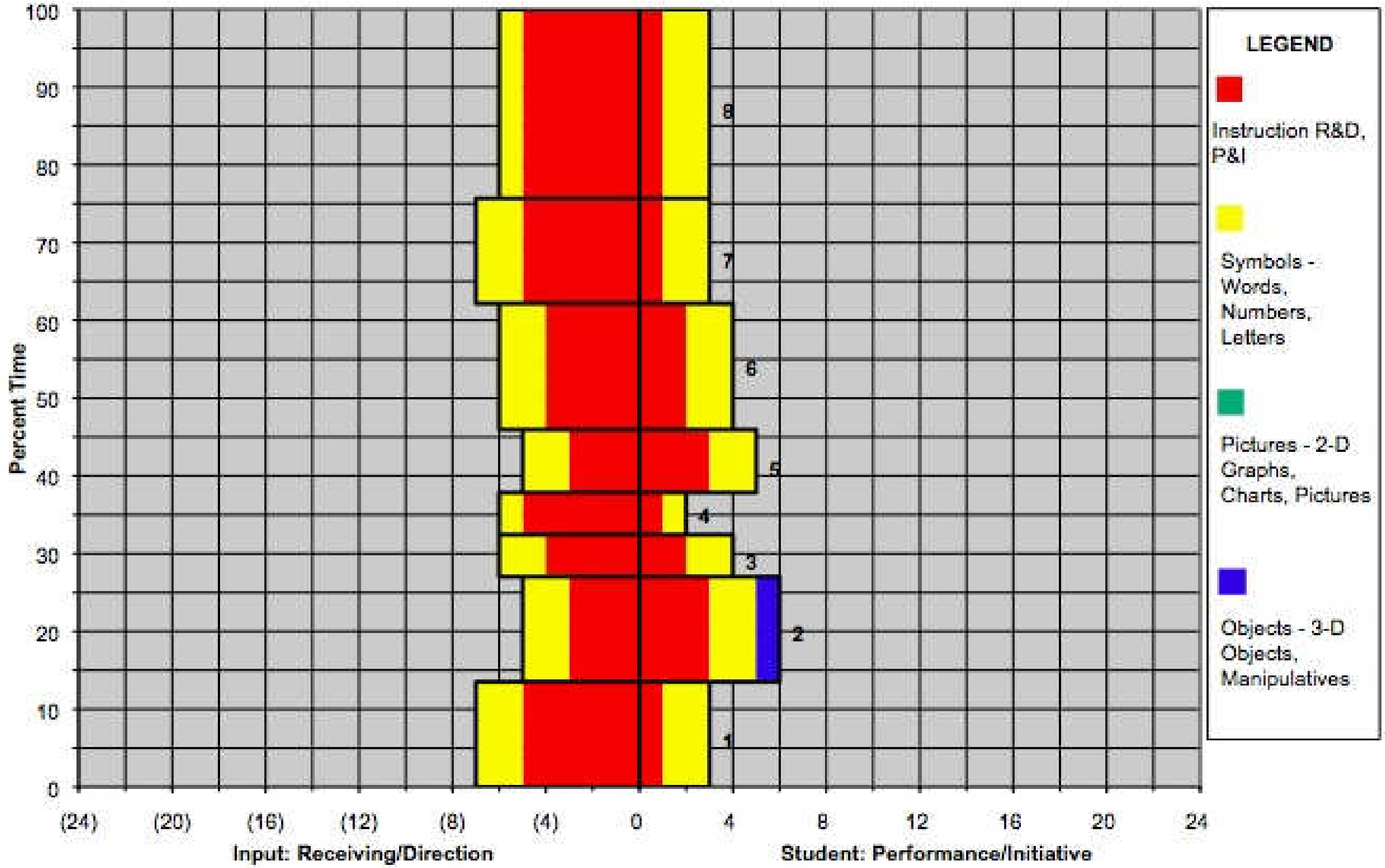

Figure 10: M-SCOPS Profile from the initial observation of Rhonda Lipsey's class

Heidi Conklin–Diocese Case #3

At the time of this study Heidi taught advanced placement psychology and environmental science to 11^{th} and 12^{th} grade students at an all-boys Catholic high school. An eight-year veteran, she spent four of those years working at her current school. Heidi invited me to observe her environmental science class, which was made up of all senior level students. The day I went to observe her class was the third to last day of classes for her students. The following week they would be celebrating their graduation with a "senior week" filled with fun field trips and activities.

Heidi told me that she had received a small grant in collaboration with the local zoo and botanical gardens. The goal of this funding was to engage students in raising plant species that were endangered or that would attract endangered species of insects. She had used part of the finding to purchase a small green house. The day I visited her students were hard at work trying to build it before the end of the year.

The foundation for the green house had already been laid and students were reading the instructions and figuring out how the pieces went together. Heidi had provided gloves and various tools. Her students worked energetically. Their interactions with Heidi demonstrated that they had an easy-going, yet respectful, working relationship with her.

The activities I observed were not part of a formal lesson. The goal of the class was simply to get the green house built. **Because there were no learning goals or premeditated design to the day's class, it was not evaluated using the M-SCOPS or the ITC COP.**

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.95	3.37	2.43	5.15	3.55

Heidi's confidence level scores rank the highest in the group on both the STEBI personal beliefs and the leadership confidence scales. Her score on the Leadership confidence scale placed her as an outlier (beyond what would be expected in a normal distribution). Her responses also ranked her in the top fourth of the group on the STEBI outcome expectancy and the knowledge/skills scale on the leadership survey. In contrast, her current responsibilities score was the second lowest score, suggesting that while she believed she could be an effective teacher leader, she did not have, prior to participation in this project, a great amount of responsibility to put her beliefs into action. Further evaluation will allow the examination of the relationship between strong motivation and self-confidence with effective leadership.

Emily Bolen– Diocese Case #4

At the time of this study Emily taught science to 4^{th} through 8^{th} grade students at a rural K-8 Catholic school. She had been a teacher for 14 years and spent nine of those years at her current school. I had been invited to observe her 7^{th} grade class where students were beginning a weeklong investigation about diet and nutrition. There were ten students in this class. All of them were White and seven of them were female.

Observation Description

Students shuffled into class and quickly took their seats. Emily began class by telling her students that they would be beginning an investigation about their eating habits and nutrition that day. She passed out two short articles and a list of nutrition websites that her students had compiled. While she passed out the papers she answered a few questions about quizzes and projects (segment 1).

Emily explained to her students that the investigation they would start that day would deal with their diet, the food they eat, their health, and science. She told them that by the end of class they should decide on something they could realistically change about their diet and how they might measure the effects that change had on them. She asked students to name some of the problems they could see in their diets and what they might want to change. One student offered that he thought he ate too much junk food, another student stated that she thought that she didn't eat enough protein. Emily loosely discussed these ideas along with the changes that could be made to address them and effects that could be measured for several minutes. Several students stated that they didn't exactly understand what they were supposed to do. Emily gave a few more examples of dietary changes that students might be able to make and how they might measure the effects of those changes (segment 2). She then told them to use the computers and other resources in the room to get some other ideas and to develop a plan for what they would change and measure over the weekend. Students worked and discussed their ideas with each other and Emily until the end of the class (segment 3).

M-SCOPS Analysis

The M-SCOPS Profile that represents Emily's class can be found in Figure 11. This 40-minute class consisted of three segments where students spent 70% of class time discussing their assignment with the teacher at a level "4/2." Students worked in small groups at a level "3/3" on the design of their nutritional experiment for the remaining 30% of class time. The entirety of class time was spent focusing on words and symbols. For the first two segments, which occupied 70% of class time, students were engaged in lower level skills at IS levels 1-3 of listening, telling, and identifying parts as they strove to understand the assignment they were being given. Students spent the remaining 30% of class time engaged them in higher-level skills at an IS level of 5 as they analyzed their nutritional situations and planned their experiments.

ITC COP Analysis

Design Score: 2

During this lesson students began a weeklong investigation of diet and nutrition. Students were asked to change something they thought was problematic in their diet and that they could measure the effect of over the weekend. This assignment was highly open-ended and appeared to lack a clear sense of purpose and direction. The majority of the class was spent helping students understand the assignment, which indicated a lack of careful planning. Because the majority of the lesson was spent on students understanding what they were supposed to do, there were few opportunities for in-depth discussion or sense making of content. The lack of a defined closure segment on the M-SCOPS Profile demonstrated that there was no time or structure provided for wrap-up.

Implementation Score: 2

The majority of this lesson was focused on students understanding their assignment. Students appeared to be a bit overwhelmed by the assignment and asked questions that demonstrated their confusion. It seemed many students had an insufficient understanding of concepts underlying diet and nutrition to decide the changes that could be made over the weekend or the effects of the changes that they could measure. Emily provided lots of ideas and encouragement but it seemed that these ideas complicated students' understanding and that a more linear or structured approach to content delivery may have been beneficial.

Science Content Score: 2

There little formal content provided for students during this lesson. Rather, students were given an open-ended assignment through which they could learn the content on their own. The lack of structure and a clearly visible sense of purpose or direction to this assignment made it difficult to evaluate how significant or worthwhile the content they would learn might be. The majority of the lesson was focused on students understanding the assignment. The discussions involved in understanding the assignment did not appear to engage students with ideas important for students to understand and the few connections among ideas and to other disciplines that were made appeared to be too abstract for the students to fully understand.

Classroom Culture Score: 3

The atmosphere in Emily's classroom was friendly and all students were encouraged to participate in the discussion. Students inquired about Emily's ideas respectfully, and there was a back and forth discussion as students strove to understand their assignment. Since the focus of the lesson was on understanding the assignment, there were few opportunities for students to critique or challenge each other's ideas in ways consistent with investigative science. However, during the last segment of class time where students worked on developing their plans, they did appear to discuss their ideas with one another and help each other think about their plans.

Capsule Description: Level 2 – Elements of Effective Instruction

The unstructured assignment that this class was based on appeared to confuse many students. This confusion appeared to stem from students' lack of understanding of diet and nutrition and caused them to focus on superficial problems in their diet that were unconnected to significant learning goals. Emily gave students many examples and encouraged them to think about their diets, but it appeared that these techniques were insufficient to address the difficulties students encountered. Overall, this lesson was seen as quite limited in its ability to enhance students understanding of science content or process.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.37	2.47	2.75	3.56	3.77

While Emily's responses to the STEBI personal beliefs scale placed her in the middle of the group, her outcome expectancy scale responses had the second lowest average. These scores indicated that while she believed she had a moderate level of confidence in her ability to effectively teach science, she did not believe that her actions would have a large impact on student science achievement. Based upon the observation of Emily's classroom, this may be related to the way she implemented inquiry-oriented instruction. Emily's confidence scale score for the Leadership survey revealed that her beliefs about her ability to be a teacher leader in her district were slightly above the expected average. Similarly, her perceived knowledge and skill level to carry out teacher leader responsibilities was slightly above average.

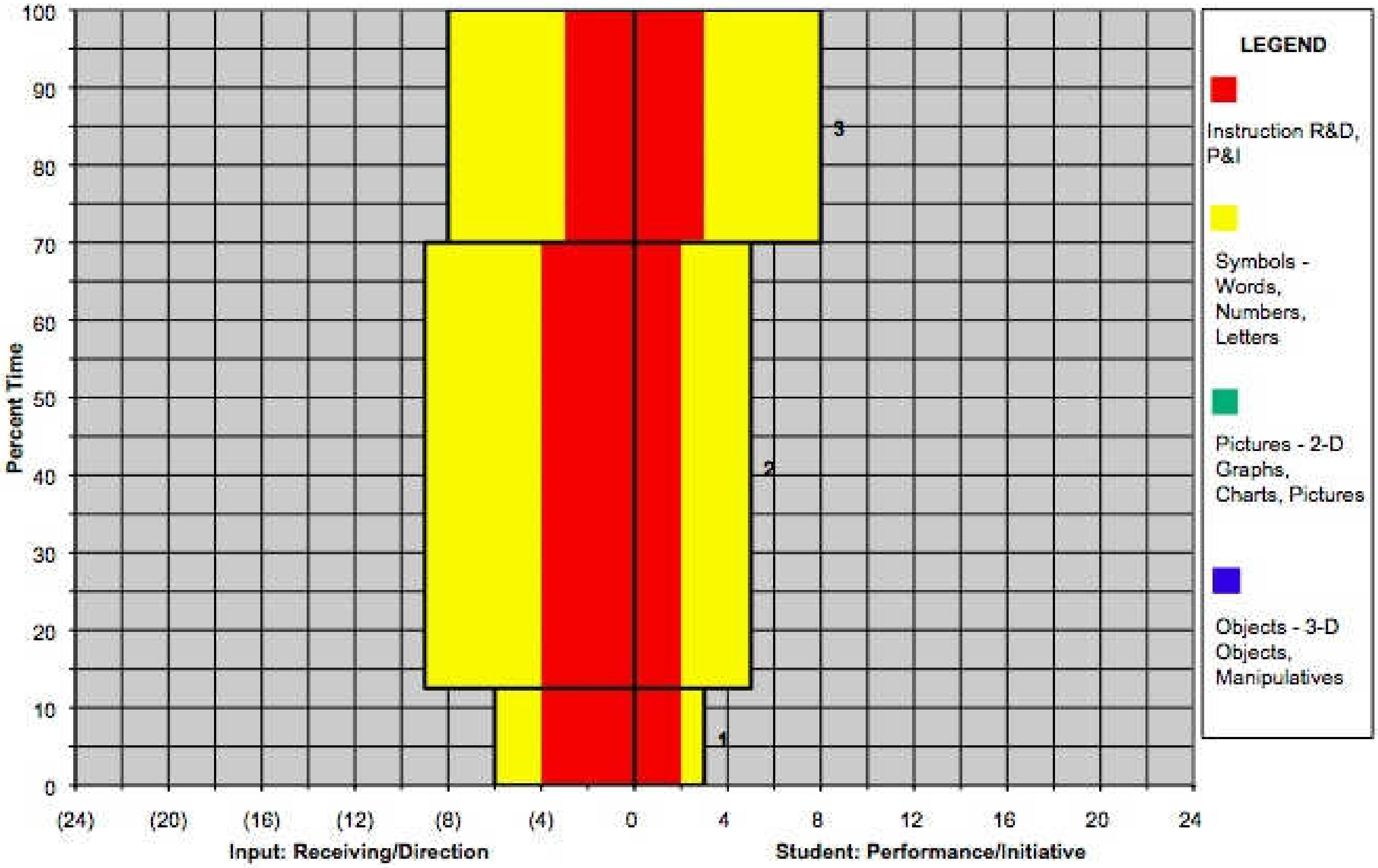

Figure 11: M-SCOPS Profile from the initial observation of Emily Bolen's class

Lynne Brandt– Diocese Case #5

At the time of this study Lynne taught science and math to 5th grade students at a K-8 Catholic school. She taught for 13 years in total and spent the last 6 of those years at her current school. Lynne received a grant from a national organization to highlight sustainable energy alternatives in her curricula. She invited me to her class on a day when her students were in the middle of putting together solar powered car kits. She explained in her post-observation interview that her learning goals for the activity were for students to understand that there were renewable and non-renewable energy sources in our world and that the sun was one source of renewable energy. Students were putting together kits to illustrate how the sun's energy could be used to power machines, such as cars. Additionally, Lynne mentioned that this activity was a reward for students' work over the course of the school year. She knew from past years that it would also hold their attention at a time of year when anticipation and excitement over the pending summer holiday was high. There were approximately 20 students in the class I observed. About half of these students were minority and about half were female.

Observation Description

I arrived at Lynne's classroom a few minutes early and caught the end of the class before to the one I had come to observe. The room was hectic and messy as students busily worked on building solar powered car models. Lynne clapped rhythmically and students enthusiastically dropped everything to repeat to her clap. She announced that it was almost time to move to their next class and students put away their cars and cleaned their workspace in a surprisingly short amount of time.

The first group of students entered the classroom as the next group entered. They chatted with one another while waiting for the class to begin. Lynne gave another rhythmic series of claps, which were quickly repeated by her students, and the room settled down as students listened for instructions. Lynne made a few announcements and told students that they were going to watch a quick movie, complete a group quiz on sustainable energy, and then continue working on their model cars (segment 1). Lynne started the movie and passed out the students' car kits as they watched (segment 2). After the video, Lynne asked her students how what they had just seen connected to some of their field trips they had taken and lessons they had completed (segment 3). After students had offered several connections, Lynne read about ten questions from an age appropriate quiz she found on the Internet. She asked students to stand up when they heard the answer they thought was right. After each question Lynne called on a student to explain their answer to the class, read the websites answer, and connected the answer to other ideas and experiences that had been part of the class (segment 4).

Once the quiz was finished, students eagerly began working on their cars (segments 5-9). Small groups of students rotated out into the hallway to decorate their cars while the rest remained in the classroom building them. The activity was challenging for many students and Lynne monitored the classroom and helped struggling students. As students' car construction progressed, Lynne used clapping patterns twice to focus attention on her as she demonstrated specific procedures. Students obediently stopped working and gathered around her to watch her demonstration (segments 6 and 8). Lynne had a small microphone-like device hanging around her neck that she used several times to project her voice so that all students could easily hear what she said.

About five minutes before the end of class Lynne told students it was time to clean up and get back in their seats (segment 9). Much like I had observed at the end of the last class, students had their cars put away surprisingly fast and quietly listened to Lynne as she explained their math homework (finding the area and perimeter of a baseball outfield and infield) and what they had to bring in order to attend an afterschool fieldtrip to a local baseball game, before which they would measure the field themselves, the next day.

M-SCOPS Analysis

The M-SCOPS Profile that represents Lynne's lesson can be found in Figure 12. This 47-minute lesson consisted of ten segments. The lesson began with two level "5/1" teacher directed segments, followed by a group quiz and discussion at a level "4/2." Students were then given time to work on building cars in small groups, then were brought back together for two short demonstrations of specific procedures and for a short closure at the end of class. In total, students spent 36% of class at an instructional level of "5/1," 13% at a level "4/2", and 61% at a level "3/3." Students were engaged with 2D representations for 77% of class time and 3D representations for 60%. Students worked on building their cars for 61% of class. This activity engaged students in transforming and arranging complex parts into a system, skills that fell into the IS level 4. Students were briefly engaged (4% of class time) at the higher IS level of 5 in sense making activities that encouraged them to connect prior experiences with new learning. Students rearranged their knowledge while answering a group quiz at an IS level of 3 for 9% of class time. Periods of engagement with low-level 1 or 2 skills occupied 36% of class time. This was a large portion of class time, but these segments were short (i.e. the longest was six minutes in length as students were given directions for their homework assignment) and varied (i.e. students listened, watched a video, and watched demonstrations).

ITC COP Analysis

Design Score: 4

The design of this lesson demonstrated that Lynne had a solid understanding of her students and her content. It involved a series of short engaging activities that incorporated a variety of actions that engaged students on different levels. Lynne provided multiple opportunities for students to make sense of content and connect ideas across a range of learning experiences. Building the model cars was challenging for students on many levels even thought it was a largely prescriptive activity that was not necessarily aligned with investigative science. The challenging nature of the activity provided opportunities for students to collaborate by helping each other work through the more difficult procedures.

Implementation Score: 5

Students were engaged and enthusiastic about the class activities throughout the lesson. Lynne's classroom management strategies, such as clapping and providing opportunities for students to move around, enhanced the lesson as they added variety. Lynne called her students' attention to details in the car building procedure at times when a majority of students needed to see them. This demonstrated her ability to "read" students and made her demonstrations more meaningful to them. I could not see many ways in which the implementation of this lesson could have been improved.

Science Content Score: 4

Lynne discussed her learning goals for this lesson with me during the post-observation interview. The goals she had were broad and conceptual in nature. They seemed appropriate, significant, and worthwhile for her young students. During the movie, discussion, and quiz that made up the beginning of the class, students had opportunities to make connections between multiple experiences and ideas, and through these connections the lesson was likely to portray science as a dynamic body of knowledge. The car building activity was challenging for Lynne's students and, while content may not have been a central focus of the activity, students were developing other skills, such as those involved in spatial reasoning and group work.

Classroom Culture Score: 4

Students in Lynne's class were helpful and respectful to one another and to Lynn.. They were well-behaved, responding to all of Lynne's instructions quickly and enthusiastically. Since building the model cars was a largely prescribed activity, there were few opportunities for activities that were aligned with investigative science such as idea generation, constructive criticism, or idea challenging. However, while they worked on their cars I overheard many students helping each other understand the instructions and complete the procedures.

Capsule Description: Level 4 – Accomplished Effective Instruction

Almost all of Lynne's students were engaged in purposeful and meaningful work throughout the lesson. This work also engaged students in collaborative activities as they helped each other complete the challenging activity of putting together the solar powered model cars. The only criticism was the lesson's lack of alignment with investigative science. Even though students work in this lesson could not be characterized as investigative, students were still engaged in challenging activities that called for in-depth thought and there were many opportunities for students tot help each other understand the steps involved in putting their cars together. All in all, this appeared to be an excellently designed and delivered lesson from which students could learn a great deal.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.60	2.96	2.76	2.41	2.66

Lynne's STEBI Personal Beliefs scores indicated that while she had some confidence in her ability to provide quality science instruction, she may be non-committal in her view of the impact a quality teacher could have on student science achievement. While none of the teacher leaders responses to items on the responsibility scale of the Leadership survey indicated that they were responsible for a great deal of leadership activity within their districts, Lynne's score was in the top fourth. In contrast, her confidence scale score was the lowest, suggesting that she had the least amount of confidence in her ability to be an effective teacher leader. She had the lowest score on the knowledge and skills scale in the teacher group as well (both of which fell below the expected average score of 3.0).

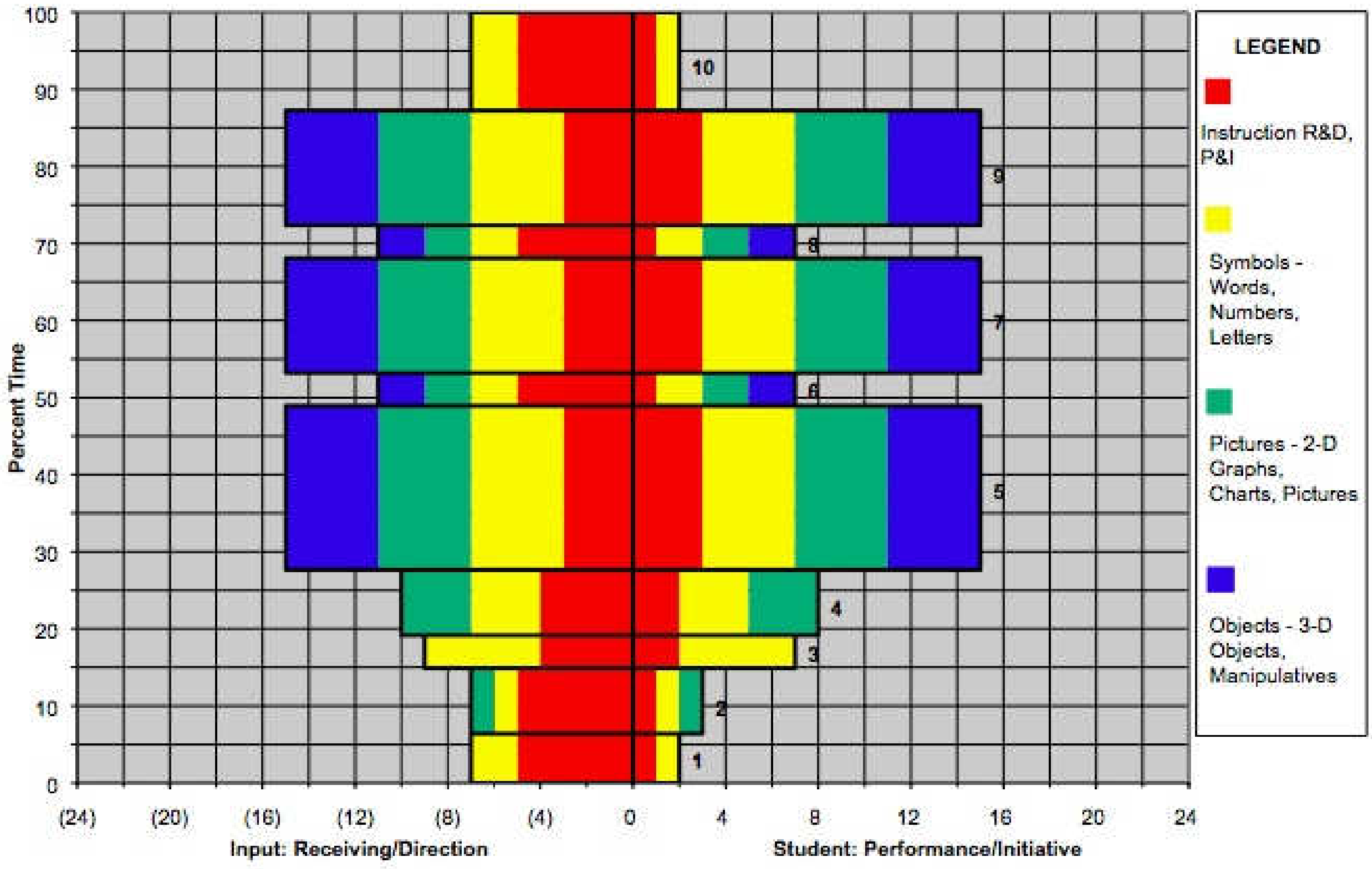

Figure 12: M-SCOPS Profile from the initial observation of Lynne Brandt's class

Claudia Farley– Diocese Case #6

At the time of this observation Claudia was a 4th grade teacher at a Catholic elementary school that served a predominantly minority population. Her school had two buildings on opposite sides of town. Prior to this year, Claudia taught second grade for seven years in the other building. She took a yearlong break and when she returned to teaching in September, she was assigned to teach fourth grade in her current building. During our post-observation interview, Claudia informed me that she would be returning to her original building and teaching second grade again the following year. Her current class consisted of approximately 20 African American students who she had all day and to whom she taught all core subjects.

Observation Description

Before her lesson began, Claudia handed me a copy of the teacher's guide that went along with the school's science text: *Scott Foresman Science*. The teacher's guide outlined a lesson that would engage students in an investigation about the density of liquids and solids. To begin the lesson, Claudia asked her students to fold a piece of paper in four, move their desks into groups, and carefully bring four cups, three half filled with water, oil, and dish detergent, and one empty, to their groups (segments 1-3). She then told her students three possible predictions they could make about how the liquids would look after they were combined and asked them all to draw one of the pictures in the first square of their sheet. After this she called on a few students to say which prediction they had chosen (segments 4-6). Students then were instructed to carefully pour the liquids together and raise their hands to tell what they observed (segments 7-8). Once a few students had stated their observations they were all instructed to draw what their cup looked like in the second square of their paper (segment 9). After drawing, students were asked to whisper to their groups their theories about why they thought the liquids had formed layers (segment 10). Claudia told the class a few theories she had heard and told them how their ideas and observations connected to a prior lesson, which had included a video, about density (segment 11). Students then went through a similar sequence of prediction and observation as they dropped a paper clip, a piece of latex glove, and a piece of Styrofoam into the layered cup (segments 12-15). During these activities the teacher encouraged the students she called on to tell their observations to the class, to describe what they observed using the phrases "less dense" and "more dense" rather than "heavier" and "lighter". Once the discussion ended students were instructed to clean up and move their desks back into rows. Once back in rows they were asked to silently complete a worksheet and finish their drawings while waiting for the lunch bell to ring (segments 16-17).

M-SCOPS Analysis

The M-SCOPS Profile that represents Claudia's lesson can be found in Figure 13. This 53-minute lesson consisted of seventeen segments. Segments were short (average length was 3-minutes) and generally moved from teacher directed instruction to teacher-led discussions, with a short period where students worked in small groups toward the end of the class. In total, 64% of class time was spent at an instructional level “5/1,” 19% at a level “4/1,” and 17% at a level “3/3.” Students were engaged with 2D representations for 58% of class time and engaged in hands-on activities that involved the manipulation of 3D objects for 40% of class time. Even though students were engaged in hands-on activities, they remained focused at low IS levels of 1 and 2 for the entire lesson. There were few opportunities for students to make sense of what they were learning or to connect their new learning with prior knowledge or other science content.

ITC COP Analysis

Design Score: 2

Claudia mentioned that she had taken the idea for this lesson from her school’s science curricula: *Scott Foresman Science*. The book she showed me provided loose guidelines for how the lesson should be conducted meaning that teacher interpretation played a large part in how the lesson would be carried out in the classroom. While materials were readily available and contributed to making the lesson efficient and orderly, Claudia’s methods of classroom management gave the lesson a very teacher-directed spin. Students’ actions and discussions were controlled, leaving little opportunity for the types of higher order conversations that would contribute to engaging prior knowledge and sense making.

Implementation Score: 2

Students performed the activities that were part of this lesson quietly and efficiently. Their on task behavior demonstrated that Claudia’s classroom management techniques were effective. She also employed short instructional segments that held students attention and kept them focused for the majority of the lesson. Even though students were well behaved and on-task throughout the class, Claudia’s teacher-directed methods decreased the alignment of the lesson with investigative science. The M-SCOPS Profile revealed that students’ thinking was maintained at a level 1 or 2 for 95% of the lesson. This pattern demonstrated that Claudia focused students on lower-level skills of observing and telling, leaving little opportunity for students to discuss their ideas of deeper questions about how or why the liquids and solids behaved the ways they did. Furthermore, students’ interchangeable use of the terms “heavier” and “denser” demonstrated that they may not have understood the difference between the two terms.

Science Content Score: 2

This lesson focused on an important scientific concept for students to understand: density. Even though the topic of the lesson was worthwhile, the high level of teacher direction and focus of the lesson on lower-level skills left little opportunity for students to engage deeply with important ideas or connect their ideas to other areas of math or science. Many student comments were addressed as being right or wrong, portraying science as a static field. In addition, Claudia’s failure to address the cause of students misuse of the terms “heavier” and “more dense” demonstrated that they may not have understood the concept of density by the end of the class.

<u>Classroom Culture Score: 2</u>

Students’ active participation was encouraged and valued and it appeared that students respected one another and the ideas of other students. The high level of teacher control, however, prevented the lesson from forming working relationships, generating questions, conjectures and/or propositions and constructively criticizing each other’s ideas. All of these characteristics are vital to investigative science and therefore, prominent aspects of the ITC COP. While the culture of the class didn’t interfere with student learning, it prevented many valuable opportunities for discussion and exploration of ideas to take place between students.

<u>Capsule Description: Level 2 – Elements of Effective Instruction</u>

The high level of teacher control and focus on lower level skills caused substantial barriers to student’s understanding of both the science concepts and processes that could have resulted from this lesson if it was carried out in a different manner. Student’s use of the term density was corrected, yet their apparent lack of understanding about the concept itself appeared to be left unaddressed. The high level of teacher control prevented opportunities for students to engage in higher-order conversations that could have contributed to their making sense of conflicting ideas. For these reasons the lesson was viewed as being quite limited in its capacity to enhance students understanding of the concepts or their ability to “do” science.

STEBI and Leadership Scores

STEBI		Leadership		
Personal Beliefs	Outcome Expectancy	Responsibility (4 pt scale)	Confidence	Knowledge & Skills
3.60	3.16	2.56	4.14	3.35

Claudia’s STEBI scores reflected a teacher who was somewhat neutral in her opinion as to her belief that teaching science effectively will yield greater student academic achievement while she had some confidence in her ability to actually teach science effectively. Her responses to the Leadership survey indicated that she had some leadership responsibility, more than average confidence in her ability to carry out those activities, and felt she had a moderate level of knowledge and skill set for the activities that she would engage in during the LEADERS Project.

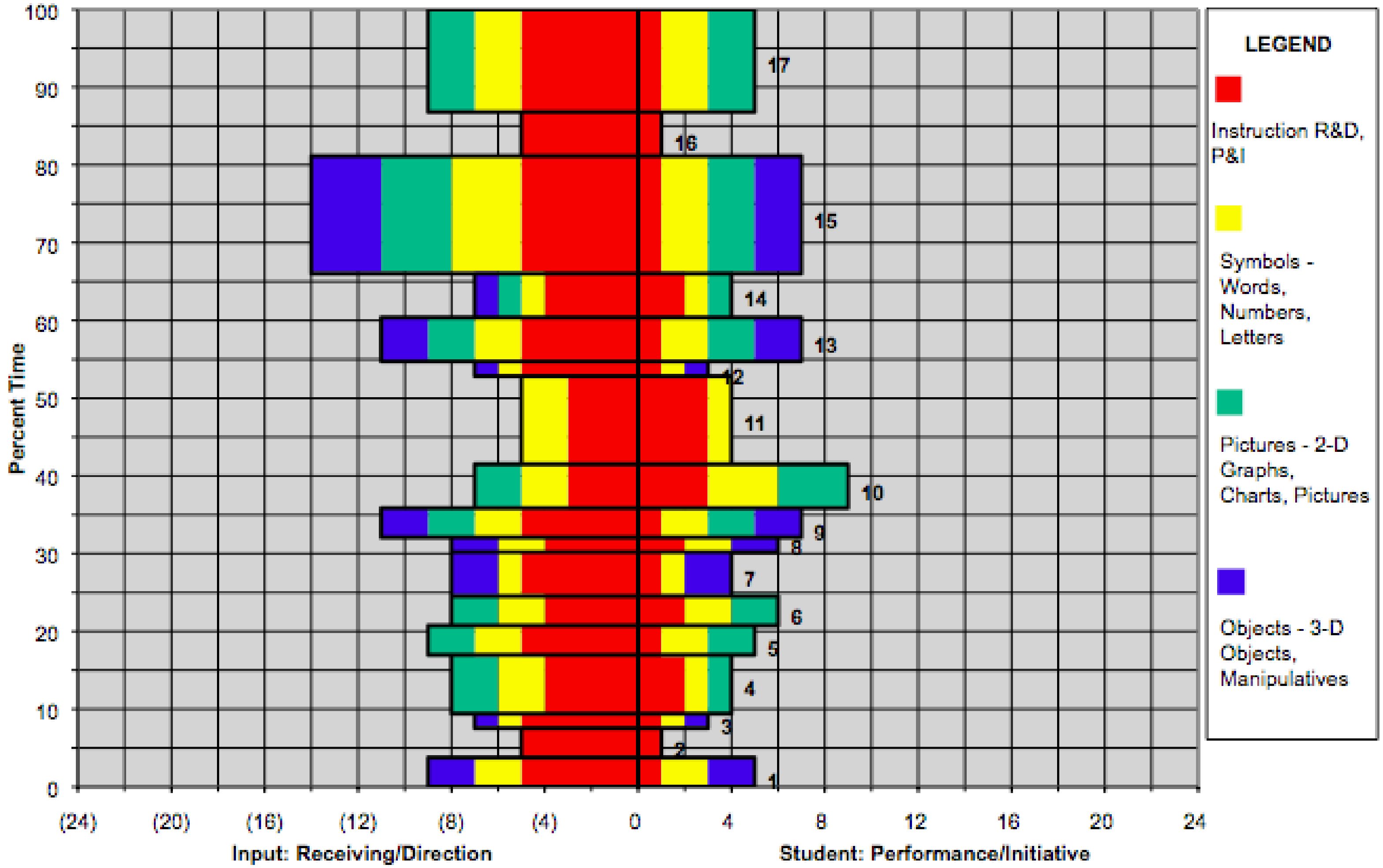

Figure 13: M-SCOPS Profile from the initial observation of Claudia Farley's class

C) Summary of Case Study Findings

The analysis of baseline observations illustrates the range of abilities, experience, attitudes, and orientations to science teaching among the LEADERS participants. ITC COP scores from the six public school teachers (Table 6) revealed that only one teacher, Deborah Samford, was observed delivering ineffective instruction. Beverly Magness scored a two, as her observed lesson focused on teacher-directed transmission of facts and did not align with the tenets of investigative science on which the ITC COP was based. Mary Rhode scored a three, as her instruction was investigative, but not highly content focused. The remaining three teachers were observed providing accomplished effective instruction.

Table 6: Comparison of TPS Teacher Scores on the ITC COP

Name	Design	Implemen-tation	Content	Culture	Overall
Beverly Magness	2	3	3	2	2 Elements of Effective Instruction
Deborah Samford	2	1	1	1	1 Ineffective Instruction
Mary Rhode	3	3	2	3	Solid 3 Beginning Stages of Effective Instruction
Irene Hobart	5	4	4	4	4 Accomplished Effective Instruction
Travis Richardson	4	4	4	4	4 Accomplished Effective Instruction
Emily Bolen	4	3	4	4	4 Accomplished Effective Instruction

Observations of the five teachers observed from the Toledo Diocese (Table 7) demonstrated a slightly different distribution. Three of the teachers were assigned the score of two or as having “elements of effective instruction” present in the observed lesson. Two of these three, Rhonda Lipsey and Claudia Farley, provided traditional, teacher-directed instruction to their classes. The third, Emily Bolen, taught a lesson more aligned with investigative science but did not appear to provide enough support to her students during it. The other two teachers, Lynne Brandt and Amanda Emerson, were give scores of four and five, or accomplished effective and exemplary instruction, respectively.

Table 7: Comparison of Toledo Diocese Teacher Scores on the ITC COP

Name	Design	Implemen-tation	Content	Culture	Overall
Amanda Emerson	5	5	5	5	5 Exemplary Instruction
Rhonda Lipsey	2	2	2	2	2 Elements of Effective Instruction
Emily Bolen	2	2	2	3	2 Elements of Effective Instruction
Lynne Brandt	4	5	4	4	4 Accomplished Effective Instruction
Claudia Farley	2	2	2	2	2 Elements of Effective Instruction

M-SCOPS Profiles (Tables 8 and 9) revealed that teachers in both school systems, except for Deborah Samford (scored as a providing ineffective instruction on the ITC COP) managed their classes well and utilized a majority of class time for instruction. Students in classes that received lower scores on the ITC COP were generally focused on low-level activities for the majority of class. M-SCOPS Profiles also demonstrated that most of the teachers varied the activities students engaged in from purely teacher-directed modes such as lecture, and provided opportunities for students to discuss ideas either as a whole class or in small groups. The one exception to these two observations was Emily Bolen who appeared to provide too little structure and guidance for her students to perform at the levels they were being asked.

Table 8: M-SCOPS Comparison of TPS Teacher Observations

Name	% of class time spent on instructional activities	% instructional time[1] on IS level 1 and 2 activities	% instructional time[1] at an instructional level "5/1"
Beverly Magness	87	100	9
Deborah Samford	75	100	49
Mary Rhode	100	19	12
Irene Hobart	100	21	32
Travis Wright	100	6	6
Sheri Jacobs	100	71	65

[1] "Instructional time" excludes time not spent on instructional activities, and refers to the percentage of time out of only the time spent on formal instruction

Table 9: M-SCOPS Comparison of Toledo Diocese Teacher Observations

Name	% of class time spent on instructional activities	% instructional time[1] on IS level 1 and 2 activities	% instructional time[1] at an instructional level "5/1"
Amanda Emerson	88	48	25
Rhonda Lipsey	100	100	57
Emily Bolen	100	13	0
Lynne Brandt	100	36	36
Claudia Farley	100	94	64

[1] "Instructional time" excludes time not spent on instructional activities, and refers to the percentage of time out of only the time spent on formal instruction

Direct observation data linked with quantitative survey findings improved our understanding of the teacher classroom practices prior to participation in LEADERS and laid the foundation for measurement of the impact the Summer Institute and the academic year follow up will have on the teacher leaders. This pragmatic mixed-methods approach will provide insight into characteristics, experiences, abilities and beliefs that can help both the LEADERS Project and other projects with similar goals, to choose exemplary candidates, to tailor their projects to the individual strengths and weaknesses of the participants, and provide worthwhile experiences and support to them in order to foster the best possible teacher leaders.

LEADERS Teacher Leader Content Gain during Summer Institute

Teacher leaders along with a science administrator from the Toledo Catholic Diocese (n = 13) completed two three credit hour university graduate courses covering advanced renewable energy science at The University of Toledo during the Summer Institute: *Physical Principles of Energy Sources for Humans* and *Chemical Aspects of Sustainable Energy.* The *Physical Principles* course involved the study of various conventional and unconventional sources of energy for human consumption including food (agricultural, horticultural, and hunting sources), plant produce (wood, grass), animal power (horses, oxen and others), fossil fuels in solid (coal), liquid (crude oil), and gas (natural gas) forms. Alternative sources include hydroelectric, wind, solar photovoltaic, solar thermal, solar-thermal-electric, tidal and wave, geothermal, thermoelectric, bio-diesel, bio-ethanol, nuclear, and human and industrial waste. Each source of energy was analyzed using a variety of criteria such as the physical mechanism of energy production, world-wide abundance, energy returned on energy invested, continuity of flow (dispatch-ability), convenience, safety, environmental pollution (including visual, audio, chemical, and biological), portability, peak power, and storage.

Chemical Aspects examined the chemistry of primary sustainable energy resources including storage devices such as fuel cells and batteries including:

1. The role of chemistry in sustainable energy systems
2. Advantages and disadvantages of biomass and fossil fuels, a chemical perspective
3. Biomass and fossil fuels as a chemical feedstock, process atom economy and energy balance
4. Fuels of today and into the future
5. Hydrogen fuel; from source to use, and the chemistry of hydrogen storage
6. Chemistry in fuel cells, energy storage and battery technology
7. Solar photovoltaic; chemical overview, historical view on “first generation”
8. Solar photovoltaic; current employment of chemistry in “second generation”
9. Solar photovoltaic; a look into future systems
10. Nature’s sources of energy; photosynthesis and hydrogenases
11. The chemistry of wind power; materials used in turbine design
12. The chemistry involved in geothermal and ocean energy resources
13. Nuclear energy; sources of fuel, refining and treatment of waste material
14. Energy use in the transportation sector
15. Overview of chemistry as applied to energy

Faculty instructors (scientists) for each course developed a test to be used in a pretest/posttest design in order to measure participant content knowledge gains. The tests were submitted to the project evaluator, Mentzer, prior to administration and she then provided suggestions to improve test quality such as limiting the number of factual recall items, including items that measured higher-order thinking, and using a scoring rubric on open-ended items in order to facilitate consistent and reliable scoring.

The faculty instructor of the *Physical Principles* course did not change the content of his test (100% factual recall) but did reduce the number of items from 80 to 40. A one-tailed paired sample t-test was conducted in order to determine the level of content gain. This comparison did not include one teacher (n=12) because of absence due to illness on the day of the posttest. **The**

results showed a statistically significant gain on the posttest ($\alpha < 0.0001$). Actual results are below:

t-Test: Paired Two Sample for Means
Physical Principles Course

	Variable 1	*Variable 2*
Mean	31.51	74.89
Variance	60.68	67.24
Observations	12.00	12.00
df	11.00	
t Stat	-18.60	
P(T<=t) one-tail	**0.0001**	
t Critical one-tail	1.80	

The faculty instructor of the *Chemical Aspects* course worked with his graduate student to develop the pretest/posttest. The test was comprised of open-ended items that could be answered in varying degrees of complexity. After the pretest was completed, the graduate assistant realized that he did not take into account that there were degrees of correct answers to each item. Working with Mentzer, he developed a scoring rubric for each item and rescored the pretest. The same test and scoring rubric was used for the posttest.

A one-tail paired sample t-test was performed to examine gains. Results are provided in the table below:

t-Test: Paired Two Sample for Means
Chemical Aspects Course

	pretest	*posttest*
Mean	55.92	70.62
Variance	241.41	19.26
Observations	13	13
df	12	
t Stat	-4.43	
P(T<=t) one-tail	**0.0004**	
t Critical one-tail	1.78	

Participants realized a statistically significant gain in the content covered in the *Chemical Aspects* course over the three week period ($\alpha < 0.000$). The large variance on the pretest is an artifact of the varying levels of content mastery at the beginning of the institute. The much smaller variance on the posttest indicates that the gaps between competency levels of the teacher leaders at the onset of the Institute have narrowed substantially.

Recommendations: Initially the faculty instructors had difficulty understanding the purpose of the pretest/posttest design. It is recommended that the science educators work with the scientists who will be teaching during the 2011 Summer Institute to facilitate their understanding of educational measurement and the role this measure plays in determining the attainment of project goals. Once course goals have been determined, the scientist, science educator, and any science graduate assistants assigned to the project should collaborate to develop an appropriate test to be used to measure content gain. The test should be completed and submitted to Mentzer for review (by April 2011) to enhance test validity (e.g., “Is it a well-constructed test with no ambiguities? Is the scoring method fair and consistent?”).

Findings from the LEADERS Summer Institute Exit Focus Group Interview

On July 23, 2010, all 12 teacher leaders and one principal met with the project evaluator to provide their perception of the recruiting process and the Summer Institute as outlined in the project evaluation *Level 1: Participants' Reactions*. According to the Guskey model of Five Critical Levels of Professional Development Evaluation (2000), this first critical level of provides project personnel with valuable information that can improve the process of the professional development including design, delivery, and activities. The interview answered questions concerning three major areas—recruiting and application, Summer Institute course delivery and activities, and Summer Institute design.

(1) Recruiting and Application Process

Most teacher leaders learned about the LEADERS program through a flyer that was distributed at the schools. In addition, in the Toledo Catholic Diocese, the Assistant Superintendent sent an email to all eligible science teachers. Teachers in this district felt the email brought their attention to the program and the flyer then provided the details. Science teachers in the Toledo Public Schools also received a flyer. There was a district-wide meeting held to better inform interested teachers of the opportunity. Some of the teacher leaders attended that meeting but a few were not aware of it. Another who had a conflict that day followed up personally to get the information. One teacher also mentioned that the press release article in the *Toledo Blade* November 2009 initially piqued the teacher's interest in the program.

The teachers were unanimous in their response that **the main attraction to this program was the renewable energy content**. The offering of graduate level courses and the possibility of earning a Master's degree were also attractive. The application process was clear and easy to follow.

Prior to being selected as a teacher leader, the teachers did not feel that they fully knew what would be expected of them. They agreed that they would have liked to have more information about time commitments and implementation expectations prior to applying for the program. All were appreciative of the effort the project personnel put forth as far as enrolling the teachers in the University and handling many of the bureaucratic snags that cropped up due to the uniqueness of the program. While they were aware that there were problems in the enrollment process, they felt that the project personnel did the brunt of the work to iron out difficulties and that they themselves were only slightly inconvenienced.

(2) Summer Institute Course Delivery and Activities

The teachers spent time discussing the differences between the delivery of the physics course and the chemistry course. They felt that chemistry learned from what occurred in physics. In general, they found the physics course to be more about economics rather than physics and to rely too heavily on details rather than concepts. Physics did not blend content with application. One teacher offered that the teacher secured a tutor to assist with comprehending physics concepts but because the content was more economic-related and because most of the assignments dealt with memorization of facts, the tutor was of no help. There was a consensus that the focus on fossil fuels in physics was not what they had anticipated and that they were hoping for more renewable energy content. The teachers agreed that the workload was consistent with graduate level courses; however, based upon previous experiences on other grant-funded projects at The University of Toledo, some teachers did not expect this degree of work. Both the project-based science course and leadership courses were well received and teachers appreciated that time within each course was set aside for group work.

The elementary teachers did not see the support they expected as far as assistance in the content courses. There was no time set aside to work in teams on content mastery for either of the content courses. The instructor of chemistry, however, appeared to be more conscious of the individual teacher's levels of comprehension and paced his course accordingly. He also allowed for more classroom application of content to be integrated into his course.

Several teachers indicated that the videos of classes were a useful tool. Many reviewed them in the evenings. The guest speakers from local renewable energy industry were also well-received although some were perceived as being there to advertise their companies rather than enhance instruction. All of the teachers felt they learned something about economic development, renewable energy, project-based science, and leadership.

(3) Summer Institute Design

All of the teachers felt that the original design—a four week institute—would have been unmanageable. They felt the content courses were rushed even in the two three-week periods. Additionally, the physics class did not include regular breaks mid-way through the class period (3 hours). This made the class quite uncomfortable for many of the teachers. Overall, the teachers recommended a different use of time during the six-week institute. Rather than a three week, morning-only content course, they recommended that time from the afternoons during weeks three and four be integrated into the content courses. For example, a field trip to a wind energy facility would have made more sense to them during the physics course rather than after it. Some of the time spent listening to guest speakers would have been better spent working in groups *during* the content course to provide the elementary teachers with group support and to facilitate working in teams. They recommended the hour from 4:00 to 5:00 PM each day be set aside for collaboration.

Teachers felt the working lunches that occurred during the first two to three weeks of the Institute were a burden and added to the stress level of immersing themselves in advanced content. Many times the working lunches were scheduled to take care of unanticipated elements of the program such as learning how to use the Inspiration software. The teachers offered that a professional development day in the spring would have been a better time to provide this information and training. In addition, a few teachers felt that an assessment of computer skills should have been conducted prior to the institute so that those who were below expected skill levels could be trained prior to commencing the Institute.

The teachers were disappointed that the computers they were given were not ready to use on the first day of the Institute. Teachers spent time discussing that they thought the computers might have been an afterthought to the project. They commented frequently that they believed the project personnel did not have a clear idea of what they themselves wanted to implement during the Institute based upon the problems with the computers and the fact that there were so many working lunches. One teacher commented that the fall implementation schedule has not been relayed to the leaders yet and that they do not know when they are expected to meet (actual dates).

The teachers did not like the extension of coursework beyond the end of the Institute. One teacher felt it important to relay the amount of work for the Institute that will be due within the weeks following it—a concept map, a 5-E lesson plan for chemistry, and a 25-30 page paper that includes a 45 slide PowerPoint for physics. One teacher felt that there was no consistency between courses as far as homework and assignment expectations. Teachers were disappointed that they had not completed the requirements of the Summer Institute within the timeframe of the Institute.

In spite of the negative aspects of the Institute they shared, all agreed that they were happy to be part of the project and they are looking forward to the academic year. They indicated they have a clear idea of their next steps as teacher leaders.

Recommendations

While the teacher leaders in general were happy with their summer experience, two major areas need attention—preparation for the Summer Institute and an Institute schedule that facilitates collaboration among the teacher leaders and balances class time with appropriate field trips and guest speakers. Once the second Summer Institute content and schedule has been set, a professional development day in the spring should introduce the schedule and Institute expectations to the teacher leaders. During that time any "housekeeping" tasks should be completed (such as learning how to use new software) so that lunch time is a time for teachers to relax and interact socially. LEADERS senior project staff should consider more flexible or creative ways of offering the courses in the summer (rather than three weeks every morning per class) so that time to work in groups or go on field trips can be integrated into the courses rather than stand-alone outside the courses. In addition, a template of content course expectations should be developed and shared with all content instructors so that concepts rather than facts are emphasized and application of content/concepts into the k-12 classroom is integrated into the content courses.

References

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Science Education Expert Content/Construct Evaluation Report

Prepared by
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Overview of the Evaluation Plan for the University of Toledo LEADERS Project: 2010

Goals of the Project:

1) Develop a cadre of effective teacher leaders who transform science education by linking science content with emerging science-based industries in Great Lakes Region.
2) Increase the number of teachers in partnering districts who have strong content, pedagogy and leadership skills and knowledge.
3) Transform existing K-12 science courses to rigorous and relevant science courses through PBS.
4) Prepare K-12 students who can meet science and mathematics achievement standards and who become interested in science and technical careers.
5) Develop community science education networks that collaborate through the development and implementation of advanced or improved science courses.

Part I: The Summer Institute

The overarching goal of the LEADERS Project is to improve science education by making it relevant to students through the integration of Project Based Science (PBS) that is linked to the renewable energies industries and its environmental impacts. Using guest speakers from local industry, scientists from the university, and science educators with expertise in PBS, the summer institute engaged teacher leaders and district personnel in course work centering on (1) Physical principles of energy sources (2) Project-Based science (3) Sustainable Energy (4) Industry seminars related to energy sources and (5) Science education Leadership and Professional development.

To that end, the evaluation of the first part of the LEADERS Project focused on collecting baseline data, examining the impacts of the summer institute, and preparing for the academic year implementation of project-based learning and staff development. In addition to science and education classes, guest speakers addressed local renewable energy projects and economic potential for the region and field trips gave participants first-hand exposure to economic development throughout the region and its reliance on the science education preparation of future employees. The institute participants were science teachers and school and district leaders.

Evaluation Protocols:

(1) Baseline data were collected by administering standard instruments assessing teachers' beliefs about science teaching (STEBI-A, Riggs & Enochs, 1990); and their context beliefs about teaching (CBAT, Lumpe, Haney & Czerniak, 2000). The STEBI instrument addresses personal levels of self-efficacy for teaching science; the CBAT instrument assesses 28 environmental factors that could influence one's ability to be an effective teacher and the likelihood that these factors existed at the participants' schools. Together both instruments give a reliable initial picture of who the participants are and how they perceive their own efficacy as it relates to science or math teaching.

(2) Entrance Survey: The LEADERS entrance survey was designed for this project in order to assess the participants' current level of responsibility and current comfort level in categories related to being a teacher leader. The categories ranged from assessing responsibility and comfort level with organizing and facilitating professional learning, coaching, working with scientists and industry partners, and providing science (energy) content support to other science educators. The survey assessed participants' knowledge base relating to cutting edge issues in contemporary education, project-based science, science standards and the needs of science teachers in their schools. Further, the survey assessed participants' beliefs about their knowledge and skills related to implementing the specific goals of the project. It is a thorough assessment designed specifically for the beginning of this project.

(3) Course reflection: based on Chickering and Gamson's seven principles for good practice in education* (1987), the LEADERS Summer Institute Course Reflection asked participants to rate specific characteristics of each course in the institute related to the degree to which the course and instructor had (1) objectives and assignments clearly communicated; (2) used audio/visuals to enhance understanding (3) returned papers, assignments, grades in a timely fashion; (4) used diverse instructional techniques; (5) provided timely responses to communication; (6) created a sense of community and belongingness; (7) encouraged participant communication and participation; (8) created access across the class and opportunities to share participant work.

(4) Leadership Survey: designed for the LEADERS project, this is an exit survey, assessing the participants' current level of responsibility and current comfort level in categories related to being a teacher leader after participation in the summer institute. The survey consists of identical items to the entrance survey and additional items addressing the participants' assessment of their responsibility and comfort level to carry out communication and professional development tasks related to the LEADERS Project. Further, the exit survey used identical questions to the entrance survey to assess knowledge and skills related to their summer institute experiences. This is a good comparison with baseline data.

(5) For Academic Year Project-based Science (PBS) Implementation:

Making science relevant to real world problems and solutions is at the heart of the LEADERS Project. The attributes of PBS that make it the most appropriate pedagogical approach for the LEADERS project include: beginning with a relevant, driving question; designing and implementing scientific investigations; making sense of data; incorporating technology; student collaboration; self and peer assessment of final product. PBS engages students in extended inquiry into complex, realistic questions, such as those related to alternate energy sources and their uses.

For the analysis of Project-Based Science Lesson Plans, an assessment rubric was developed for this project that addresses the attributes of PBS and follows a format similar to the Classroom Observation and Analytic Protocol developed by Horizon Research (2000). The rubric is to help evaluate written lesson plans and it is intended to capture the essence of the lesson design. Both a rationale and guidelines for use are included with the Rubric and key indicators help to make sense of the PBS attributes and provide justification for the overall ratings for each section of the lesson plan. A final "Capsule Description" of the quality of the PBS lesson represents a well scaffolded discussion of the attributes of the lesson plan.

Areas for further evaluation:

Looking ahead: The evaluation design, implemented thus far, provides and has the potential to provide, rich data related to goals 2-5 (above) of the LEADERS Project. More needs to be developed in relation to goal 1: "Develop a cadre of effective teacher leaders who transform science education by linking science content with emerging science-based industries in Great Lakes Region." Beyond assessing their self-efficacy in this area through the entrance and exit surveys (#2 and #4 described in the previous section), there is a need to specifically address participants' understanding of the ways to link science content to emerging local science –based industries in their grade-level science curriculums. That being said, there is the opportunity to assess this linkage through the content of the Project-Based Science Curriculum Units. The assessment rubric for these units has the potential to become a model for Project-based learning.

Respectfully submitted,

Janice Koch

Janice Koch, Ph.D.
Science educator and Consultant

*encourages contact between students and faculty, develops reciprocity and cooperation among students, encourages active learning, gives prompt feedback, emphasizes time on task, communicates high expectations, and respects diverse talents and ways of learning.

Next Steps

In September, teacher leaders will be asked to complete surveys as to the effectiveness of the Summer Institute courses (based on *7 Principles of Effective Instruction*). This assessment was delayed in order to allow the teacher leaders time to reflect on their summer experience. Control and treatment schools for the Toledo Public School district have not yet been selected due to possible school closings and teacher reassignments. Once the district has finalized these decisions, the control and treatment schools will be randomly selected by the project evaluator (to ensure objectivity). The evaluation team will then survey teachers in these schools per the project evaluation plan (September/October) to gather both baseline data and to verify group equivalency). Project Based Science lessons developed by the teacher leaders will be examined using a scoring rubric developed by Brooks (evaluation post-doctoral assistant) in the fall and, prior to its use, elements will be added to examine the extent to which the lessons incorporate renewable energy content tied to local economic growth. Baseline data from all LEADERS MSP partners will be collected in September/October and social networking as a means of evaluating the partnership and learning community will be explored. All other evaluation measures will be conducted as outlined in the LEADERS Evaluation Plan submitted to the National Science Foundation Math-Science Partnership program.

APPENDIX

Beliefs About My Science Teaching (STEBI-A, Riggs & Enochs, 1990)

Please circle the response that best matches your level of agreement using the following scale:
SA = strongly agree *A = agree* *UN = unsure* *D = disagree* *SD = strongly disagree*

1. When a student does better than usual in science it is often because the teacher exerted a little extra effort.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
2. I am continually finding better ways to teach science	SA ☐	A ☐	UN ☐	D ☐	SD ☐
3. Even when I try very hard, I don't teach science as well as I do most subjects	SA ☐	A ☐	UN ☐	D ☐	SD ☐
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
5. I know the steps necessary to teach science concepts effectively.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
6. I am not very effective in monitoring science experiments	SA ☐	A ☐	UN ☐	D ☐	SD ☐
7. If students are underachieving in science, it is most likely due to ineffective science teaching	SA ☐	A ☐	UN ☐	D ☐	SD ☐
8. I generally teach science ineffectively	SA ☐	A ☐	UN ☐	D ☐	SD ☐
9. The inadequacy of a student's science background can be overcome by good teaching	SA ☐	A ☐	UN ☐	D ☐	SD ☐
10. The low science achievement of some students cannot generally be blamed on their teachers.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher	SA ☐	A ☐	UN ☐	D ☐	SD ☐
12. I understand science concepts well enough to be effective in teaching elementary science.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
13. Increased effort in science teaching produces little change in some students' science achievement	SA ☐	A ☐	UN ☐	D ☐	SD ☐
14. The teacher is generally responsible for the achievement of students in science.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching	SA ☐	A ☐	UN ☐	D ☐	SD ☐
16. If parents comment that their child is showing more interest in science at school it is probably due to the performance of the child's teacher	SA ☐	A ☐	UN ☐	D ☐	SD ☐

Please circle the response that best matches your level of agreement using the following scale:
SA = strongly agree A = agree UN = unsure D = disagree SD = strongly disagree

17. I find it difficult to explain to students why science experiments work	SA ☐	A ☐	UN ☐	D ☐	SD ☐
18. I am typically able to answer students' science questions.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
19. I wonder if I have the necessary skills to teach science.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
21. Given a choice, I would not invite the principal to evaluate my science teaching.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA ☐	A ☐	UN ☐	D ☐	SD ☐
23. When teaching science I usually welcome student questions	SA ☐	A ☐	UN ☐	D ☐	SD ☐
24. I don't know what to do to turn students on to science	SA ☐	A ☐	UN ☐	D ☐	SD ☐
25. Even teachers with good science teaching abilities cannot help some kids learn science	SA ☐	A ☐	UN ☐	D ☐	SD ☐

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teachers' science teaching efficacy belief instrument. *Science Education*, *74*, 625-637.

Inside the Classroom Teacher Interview Protocol

I appreciate your letting me observe your class. I have some questions I'd like to ask you related to this lesson. Would you mind if I taped the interview? It will help me stay focused on our conversation and it will ensure I have an accurate record of what we discussed.

Preliminary
If applicable, ask:
What is the name/title of this course?
What class period was this?
If applicable, ask:
Can I have a copy of the instructional materials you used for this lesson? [Specify what you would like to have copies of, if necessary.]

A. Learning Goals
1. I'd like to know a bit more about the students in this class.
Tell me about the ability levels of students in this class.
How do they compare to students in the school as a whole?
Are there any students with special needs in this class?
Are there any students for whom English is not their first language?
Are there any students with learning disabilities?
2. Is student absenteeism or mobility a problem for you in this class?
3. Please help me understand where this lesson fits in the sequence of the unit you are working on. What have the students experienced prior to today's lesson?
4. What was the specific purpose of today's lesson?
5. How do you feel about how the lesson played out?
What do you think the students gained from today's lesson?
6. What is the next step for this class in this unit?

B. Content/Topic
7. What led you to teach the mathematics/science topics/concepts/skills in this lesson?
(Use the following probes, as needed, so you can assess the extent of importance of each of these influences:)
Is it included in the state/district curriculum/course of study?
If yes, or previously implied: How important was that in your decision to teach this topic?
Is it included in a state/district mathematics/science assessment? What are the consequences if students don't do well on the test?
If yes, or previously implied: How important were these tests in your decision to teach this topic?
Is it included in an assigned textbook or program designated for this class?
If yes, or previously implied: How important was that in your decision to teach this topic?
C. Resources Used to Design the Lesson
8. What resources did you use to plan this lesson?
(Be sure to get details on sources of materials and activities.)
(If teacher developed materials, SKIP to part D.)

9. Were these resources/materials/activities designated for this class/course or did you choose to use them yourself?
10. What do you like about these resources/materials/activities?
(*Compared to what the district designated for the class/course, if applicable.*)
What do you not like?
11. a. *If the lesson was based on one resource/material:*
Did you plan this lesson essentially as it was organized in [name of resource/material] or did you modify it in important ways?
11. b. *If the lesson was based on more than one resource/material:*
Did you plan this lesson essentially as it was organized in any one of these resources/materials?
If yes:
Did you modify it in important ways?
12. *If modified:*
Can you describe the modifications you made and your reasons for making them?

D. The Teacher
13. How do you feel about teaching this topic?
Do you enjoy it?
How well prepared to you feel to guide student learning of this content?
What opportunities have you had to learn about this particular content area? (Probe for professional development opportunities.)
How did you become involved in these professional development opportunities?
Were they required or encouraged by the district?
How helpful were they?

14. How do you feel about teaching with this pedagogy?
How comfortable do you feel using the instructional strategies involved in teaching this lesson?
What opportunities have you had to learn about using these strategies? (Probe for professional development opportunities.)
How did you become involved in these professional development opportunities?
Were they required or encouraged by the district?
How helpful were they?

15. How many years have you been teaching prior to this year?
Have you taught this lesson before?
If yes: How different was today from how you have taught it previously?
Is there anything about this particular group of students that led you to plan this lesson this way?
16. *If applicable ask*:
I noticed there was another adult in the classroom. Who was that and what was his/her role?

E. Context
17. Sometimes schools and districts make it easier for teachers to teach science/mathematics well, and sometimes they get in the way.
What about your teaching situation influenced your planning of this lesson?
PROBES:
Did the facilities and available equipment and supplies have any influence on your choice of this lesson or how you taught it?

Were there any problems in getting the materials you needed for this lesson?

18. Sometimes other people in the school and district can influence your planning of a lesson.
Did your principal have any influence on your choice of this lesson or how you taught it?
Other teachers in the school?
Parents/community?
School board?
District administration?
Anyone else?

Thank you for your time. If I have any additional questions or need clarification, how and when is it best to contact you?

Inside the Classroom
Teacher Interview Protocol

I appreciate your letting me observe your class. I have some questions I'd like to ask you related to this lesson. Would you mind if I taped the interview? It will help me stay focused on our conversation and it will ensure I have an accurate record of what we discussed.

Preliminary

If applicable, ask:
What is the name/title of this course?

What class period was this?

If applicable, ask:
Can I have a copy of the instructional materials you used for this lesson? [Specify what you would like to have copies of, if necessary.]

A. Learning Goals

1. I'd like to know a bit more about the students in this class.
   Tell me about the ability levels of students in this class.
   How do they compare to students in the school as a whole?

   Are there any students with special needs in this class?
   Are there any students for whom English is not their first language?
   Are there any students with learning disabilities?

2. Is student absenteeism or mobility a problem for you in this class?

3. Please help me understand where this lesson fits in the sequence of the unit you are working on. What have the students experienced prior to today's lesson?

4. What was the specific purpose of today's lesson?

5. How do you feel about how the lesson played out?
   What do you think the students gained from today's lesson?

6. What is the next step for this class in this unit?

B. Content/Topic

7. What led you to teach the mathematics/science topics/concepts/skills in this lesson?

   (Use the following probes, as needed, so you can assess the extent of importance of each of these influences:)

   > Is it included in the state/district curriculum/course of study?
   > *If yes, or previously implied:* How important was that in your decision to teach this topic?
   >
   > Is it included in a state/district mathematics/science assessment? What are the consequences if students don't do well on the test?
   > *If yes, or previously implied:* How important were these tests in your decision to teach this topic?
   >
   > Is it included in an assigned textbook or program designated for this class?
   > *If yes, or previously implied:* How important was that in your decision to teach this topic?

C. Resources Used to Design the Lesson

8. What resources did you use to plan this lesson?
   (Be sure to get details on sources of materials and activities.)
   (If teacher developed materials, SKIP to part D.)

9. Were these resources/materials/activities designated for this class/course or did you choose to use them yourself?

10. What do you like about these resources/materials/activities?
    (*Compared to what the district designated for the class/course, if applicable.*)
    What do you not like?

11\. a. *If the lesson was based on one resource/material:*
Did you plan this lesson essentially as it was organized in [name of resource/material] or did you modify it in important ways?

11\. b. *If the lesson was based on more than one resource/material:*
Did you plan this lesson essentially as it was organized in any one of these resources/materials?
If yes:
Did you modify it in important ways?

12\. *If modified:*
Can you describe the modifications you made and your reasons for making them?

D. The Teacher

13. How do you feel about teaching this topic?
    Do you enjoy it?
    How well prepared to you feel to guide student learning of this content?
    What opportunities have you had to learn about this particular content area?
        (Probe for professional development opportunities.)
    How did you become involved in these professional development opportunities?
    Were they required or encouraged by the district?
    How helpful were they?

14. How do you feel about teaching with this pedagogy?
    How comfortable do you feel using the instructional strategies involved in teaching this lesson?
    What opportunities have you had to learn about using these strategies?
        (Probe for professional development opportunities.)
    How did you become involved in these professional development opportunities?
    Were they required or encouraged by the district?
    How helpful were they?

15. How many years have you been teaching prior to this year?
    Have you taught this lesson before?
    If yes: How different was today from how you have taught it previously?

    Is there anything about this particular group of students that led you to plan this lesson this way?

16. *If applicable ask*:
    I noticed there was another adult in the classroom. Who was that and what was his/her role?

E. Context

17. Sometimes schools and districts make it easier for teachers to teach science/mathematics well, and sometimes they get in the way.
    What about your teaching situation influenced your planning of this lesson?

    PROBES:
    Did the facilities and available equipment and supplies have any influence on your choice of this lesson or how you taught it?
    Were there any problems in getting the materials you needed for this lesson?

18. Sometimes other people in the school and district can influence your planning of a lesson. Did your principal have any influence on your choice of this lesson or how you taught it?

    Other teachers in the school?
    Parents/community?
    School board?
    District administration?
    Anyone else?

Thank you for your time. If I have any additional questions or need clarification, how and when is it best to contact you?

Inside the Classroom
Observation and Analytic Protocol

Observation Date: ______________________________ Time: Start: ________________ End: ______________

School: ____ District: _______________________________________

Teacher: ____

PART ONE: THE LESSON

Section A. Basic Descriptive Information

1. Teacher Gender: ___ Male ___ Female

   Teacher Ethnicity:
   ___ American Indian or Alaskan Native
   ___ Asian
   ___ Hispanic or Latino
   ___ Black or African-American
   ___ Native Hawaiian or Other Pacific Islander
   ___ White

2 Subject Observed: ___ Mathematics ___ Science

3. Grade Level(s): ___________

4. Course Title (if applicable) ____

   Class Period (if applicable) ____

5. Students: _______ Number of Males ________ Number of Females

6. Did you collect copies of instructional materials to be sent to HRI?

   ☐ Yes ☐ No, explain:

Section B. Purpose of the Lesson:
In this section, you are asked to indicate how lesson time was spent and to provide the teacher's stated purpose for the lesson.

1. According to the teacher, the purpose of this lesson was:

2. Based on time spent, the focus of this lesson is best described as: (Check one.)

- ○ Almost entirely working on the development of algorithms/facts/vocabulary
- ○ Mostly working on the development of algorithms/facts/vocabulary, but working on some mathematics/science concepts
- ○ About equally working on algorithms/facts/vocabulary and working on mathematics/science concepts
- ○ Mostly working on mathematics/science concepts, but working on some algorithms/facts/vocabulary
- ○ Almost entirely working on mathematics/science concepts

Section C. Lesson Ratings
In this part of the form, you are asked to rate each of a number of key indicators in four different categories, from 1 (not at all) to 5 (to a great extent). You may list any additional indicators you consider important in capturing the essence of this lesson and rate these as well. Use your "Ratings of Key Indicators" to inform your "Synthesis Ratings". It is important to indicate in "Supporting Evidence for Synthesis Ratings" what factors were most influential in determining your synthesis ratings and to give specific examples and/or quotes to illustrate those factors.

Note that any one lesson is not likely to provide evidence for every single indicator; use 6, "Don't know" when there is not enough evidence for you to make a judgment. Use 7, "N/A" (Not Applicable) when you consider the indicator inappropriate given the purpose and context of the lesson. This section also includes ratings of the likely impact of instruction and a capsule rating of the quality of the lesson.

I. Design

A. Ratings of Key Indicators

	Not at all				To a great extent	Don't know	N/A
1. The design of the lesson incorporated tasks, roles, and interactions consistent with investigative mathematics/science.	1	2	3	4	5	6	7
2. The design of the lesson reflected careful planning and organization.	1	2	3	4	5	6*	7*
3. The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, prior knowledge, and/or learning styles.	1	2	3	4	5	6	7
4. The resources available in this lesson contributed to accomplishing the purposes of the instruction.	1	2	3	4	5	6	7
5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials).	1	2	3	4	5	6*	7*
6. The design of the lesson encouraged a collaborative approach to learning among the students.	1	2	3	4	5	6	7
7. Adequate time and structure were provided for "sense-making."	1	2	3	4	5	6*	7*
8. Adequate time and structure were provided for wrap-up.	1	2	3	4	5	6	7
9. ____	1	2	3	4	5		

* We anticipate that these indicators should be rated 1-5 for nearly all lessons. If you rated any of these indicators 6 or 7, please provide an explanation in your supporting evidence below.

B. Synthesis Rating

1	2	3	4	5
Design of the lesson not at all reflective of best practice in mathematics/science education				Design of the lesson extremely reflective of best practice in mathematics/science education

C. Supporting Evidence for Synthesis Rating

Provide a brief description of the nature and quality of this component of the lesson, the rationale for your synthesis rating, and the evidence to support that rating.

II. Implementation

A. Ratings of Key Indicators

	Not at all				To a great extent	Don't know	N/A
1. The instructional strategies were consistent with investigative mathematics/science.	1	2	3	4	5	6	7
2. The teacher appeared confident in his/her ability to teach mathematics/science.	1	2	3	4	5	6	7
3. The teacher's classroom management style/strategies enhanced the quality of the lesson.	1	2	3	4	5	6*	7*
4. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.	1	2	3	4	5	6*	7*
5. The teacher was able to "read" the students' level of understanding and adjusted instruction accordingly.	1	2	3	4	5	6	7
➔ 6. The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions).	1	2	3	4	5	6	7
7. ____	1	2	3	4	5		

* We anticipate that these indicators should be rated 1-5 for nearly all lessons. If you rated any of these indicators 6 or 7, please provide an explanation in your supporting evidence below.

B. Synthesis Rating

1	2	3	4	5
Implementation of the lesson not at all reflective of best practice in mathematics/science education				Implementation of the lesson extremely reflective of best practice in mathematics/science education

C. Supporting Evidence for Synthesis Rating

Provide a brief description of the nature and quality of this component of the lesson, the rationale for your synthesis rating, and the evidence to support that rating. (If available, be sure to include examples/quotes to illustrate ratings of teacher questioning (A6).)

III. Mathematics/Science Content

A. Ratings of Key Indicators

		Not at all				To a great extent	Don't know	N/A
➔1.	The mathematics/science content was significant and worthwhile.	1	2	3	4	5	6*	7*
➔2.	The mathematics/science content was appropriate for the developmental levels of the students in this class.	1	2	3	4	5	6*	7*
➔3.	Teacher-provided content information was accurate.	1	2	3	4	5	6	7
➔4.	Students were intellectually engaged with important ideas relevant to the focus of the lesson.	1	2	3	4	5	6*	7*
5.	The teacher displayed an understanding of mathematics/science concepts (e.g., in his/her dialogue with students).	1	2	3	4	5	6	7
6.	Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation analysis, and/or proof/justification.	1	2	3	4	5	6	7
7.	Elements of mathematical/science abstraction (e.g., symbolic representations, theory building) were included when it was important to do so.	1	2	3	4	5	6	7
8.	Appropriate connections were made to other areas of mathematics/ science, to other disciplines, and/or to real-world contexts.	1	2	3	4	5	6	7
➔9.	The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.	1	2	3	4	5	6*	7*
10.	____	1	2	3	4	5		

* We anticipate that these indicators should be rated 1-5 for nearly all lessons. If you rated any of these indicators 6 or 7, please provide an explanation in your supporting evidence below.

B. Synthesis Rating

1	2	3	4	5
Mathematics/science content of lesson not at all reflective of current standards for mathematics/science education				Mathematics/science content of lesson extremely reflective of current standards for mathematics/science education

C. Supporting Evidence for Synthesis Rating

Provide a brief description of the nature and quality of this component of the lesson, the rationale for your synthesis rating, and the evidence to support that rating. (If available, be sure to include examples/quotes to illustrate ratings of quality of content (A1, A2, A3), intellectual engagement (A4), and nature of "sense-making" (A9).)

IV. Classroom Culture

A. Ratings of Key Indicators

	Not at all				To a great extent	Don't know	N/A
➔1. Active participation of all was encouraged and valued.	1	2	3	4	5	6*	7*
➔2. There was a climate of respect for students' ideas, questions, and contributions.	1	2	3	4	5	6*	7*
3. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).	1	2	3	4	5	6	7
4. Interactions reflected collaborative working relationships between teacher and students.	1	2	3	4	5	6*	7*
5. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.	1	2	3	4	5	6	7
➔6. Intellectual rigor, constructive criticism, and the challenging of ideas were evident.	1	2	3	4	5	6*	7*
7. ____	1	2	3	4	5		

* We anticipate that these indicators should be rated 1-5 for nearly all lessons. If you rated any of these indicators 6 or 7, please provide an explanation in your supporting evidence below.

B. Synthesis Rating

1	2	3	4	5
Classroom culture interfered with student learning				Classroom culture facilitated the learning of all students

C. Supporting Evidence for Synthesis Rating

Provide a brief description of the nature and quality of this component of the lesson, the rationale for your synthesis rating, and the evidence to support that rating. (If available, be sure to include examples/quotes to illustrate ratings of active participation (A1), climate of respect (A2), and intellectual rigor (A6). While direct evidence that reflects particular sensitivity or insensitivity toward student diversity is not often observed, we would like you to document any examples you do see.)

Section D. Lesson Arrangements and Activities

In question 1 of this section, please divide the total duration of the lesson into instructional and non-instructional time. In question 2, make your estimates based only on the *instructional time* of the lesson.

1. Approximately how many minutes during the lesson were spent:

   a. On instructional activities? ________ minutes

   b. On housekeeping unrelated to the lesson/interruptions/other non-instructional activities? ________ minutes

Describe:

   c. Check here if the lesson included a major interruption (e.g., fire drill, assembly, shortened class period):

2. Considering only the *instructional time* of the lesson (listed in 1a above), approximately what percent of this time was spent in each of the following arrangements?

   a. Whole class _______ %

   b. Pairs/small groups _______ %

   c. Individuals _______ %

   100 %

Section E. Overall Ratings of the Lesson

1. Likely Impact of Instruction on Students' Understanding of Mathematics/Science

While the impact of a single lesson may well be limited in scope, it is important to judge whether the lesson is likely to help move students in the desired direction. For this series of ratings, consider all available information (i.e., your previous ratings of design, implementation, content, and classroom culture, and the interview with the teacher) as you assess the likely impact of this lesson. Elaborate on ratings with comments in the space provided.

Select the response that best describes your overall assessment of the *likely effect* of this lesson in each of the following areas.

		Negative effect		Mixed or neutral effect		Positive effect	Don't know	N/A
a.	Students' understanding of mathematics/science as a dynamic body of knowledge generated and enriched by investigation.	○	○	○	○	○	○	○
b.	Students' understanding of important mathematics/science concepts.	○	○	○	○	○	○	○
c.	Students' capacity to carry out their own inquiries.	○	○	○	○	○	○	○
d.	Students' ability to apply or generalize skills and concepts to other areas of mathematics/science, other disciplines, and/or real-life situations.	○	○	○	○	○	○	○
e.	Students' self-confidence in doing mathematics/science.	○	○	○	○	○	○	○
f.	Students' interest in and/or appreciation for the discipline.	○	○	○	○	○	○	○

Comments:

2. Capsule Rating of the Quality of the Lesson

In this final rating of the lesson, consider all available information about the lesson, its context and the teacher's purpose, and your own judgment of the relative importance of the ratings you have made. Select the capsule description that best characterizes the lesson you observed. Keep in mind that this rating is *not* intended to be an average of all the previous ratings, but should encapsulate your overall assessment of the quality and likely impact of the lesson.

O **Level 1**: **Ineffective Instruction**
There is little or no evidence of student thinking or engagement with important ideas of mathematics/science. Instruction is *highly unlikely* to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics/science. Lesson was characterized by either (select one below):

- ○ **Passive "Learning"**
  Instruction is pedantic and uninspiring. Students are passive recipients of information from the teacher or textbook; material is presented in a way that is inaccessible to many of the students.

- ○ **Activity for Activity's Sake**
  Students are involved in hands-on activities or other individual or group work, but it appears to be activity for activity's sake. Lesson lacks a clear sense of purpose and/or a clear link to conceptual development.

O **Level 2: Elements of Effective Instruction**
Instruction contains some elements of effective practice, but there are *serious problems* in the design, implementation, content, and/or appropriateness for many students in the class. For example, the content may lack importance and/or appropriateness; instruction may not successfully address the difficulties that many students are experiencing, etc. Overall, the lesson is *very limited* in its likelihood to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics/science.

O **Level 3: Beginning Stages of Effective Instruction.** (Select one below.)

○ Low 3 ○ Solid 3 ○ High 3

Instruction is purposeful and characterized by quite a few elements of effective practice. Students are, at times, engaged in meaningful work, but there are *weaknesses*, ranging from substantial to fairly minor, in the design, implementation, or content of instruction. For example, the teacher may short-circuit a planned exploration by telling students what they "should have found"; instruction may not adequately address the needs of a number of students; or the classroom culture may limit the accessibility or effectiveness of the lesson. Overall, the lesson is *somewhat limited* in its likelihood to enhance students' understanding of the discipline or to develop their capacity to successfully "do" mathematics/science.

O **Level 4: Accomplished, Effective Instruction**
Instruction is purposeful and engaging for most students. Students actively participate in meaningful work (e.g., investigations, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and the teacher implements it well, but adaptation of content or pedagogy in response to student needs and interests is limited. Instruction is *quite likely* to enhance most students' understanding of the discipline and to develop their capacity to successfully "do" mathematics/science.

O **Level 5***:* **Exemplary Instruction**
Instruction is purposeful and all students are highly engaged most or all of the time in meaningful work (e.g., investigation, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and artfully implemented, with flexibility and responsiveness to students' needs and interests. Instruction is *highly likely* to enhance most students' understanding of the discipline and to develop their capacity to successfully "do" mathematics/science.

Section F. Descriptive Rationale

1. Narrative

In 1–2 pages, describe what happened in this lesson, including enough rich detail that readers have a sense of having been there. Include:

- Where this lesson fit in with the overall unit;
- The focus of this lesson (e.g., the extent to which it was review/practice versus addressing new material; the extent to which it addressed algorithms/vocabulary versus mathematics/science concepts);
- Instructional materials used, if any;
- A synopsis of the structure/flow of the lesson;
- Nature and quality of lesson activities, including lecture, class discussion, problem-solving/investigation, seatwork;
- Roles of the teacher and students in the intellectual work of the lesson (e.g., providing problems or questions, proposing conjectures or hypotheses; developing/applying strategies or procedures; and drawing, challenging, or verifying conclusions);
- Roles of any other adults in the classroom, e.g., teacher's aide; and
- The reasoning behind your capsule rating, highlighting the likely impact on students' understanding of science/mathematics.

This description should stand on its own. Do not be concerned if you repeat information you have already provided elsewhere, e.g., in your supporting evidence for your synthesis ratings (e.g., implementation).

2. Lesson Features

Indicate which of the following features were included in this lesson, however briefly. Then, if NOT already described in the descriptive rationale, provide a brief description of the applicable features in this lesson.

	Check all that apply	Describe, if NOT in descriptive rationale
a. High quality "traditional" instruction, e.g., lecture	○	
b. High quality "reform" instruction, e.g., investigation	○	
c. Teacher/students using manipulatives	○	
d. Teacher/students using calculators/computers	○	
e. Teacher/students using other scientific equipment	○	
f. Teacher/students using other audio-visual resources	○	
g. Students playing a game	○	
h. Students completing labnotes/journals/ worksheets or answering textbook questions/ exercises	○	
i. Review/practice to prepare students for an externally mandated test	○	
j. More than incidental reference/connection to other disciplines	○	

PART TWO: INFLUENCES ON THE SELECTION OF TOPICS/INSTRUCTIONAL MATERIALS/ PEDAGOGY USED IN PLANNING THIS LESSON

Section A. Areas of Influence

Lessons are designed and selected for a variety of reasons, some of which are under the control of the teacher and some of which are not. In Part Two of the protocol, researchers should draw upon the teacher interview in considering how each of a number of factors influenced the selection of topics/instructional materials/pedagogy in planning for this lesson.

1. Policy and Support Infrastructure

a. Curriculum and Assessment Policies

i. When talking about why s/he chose the mathematics/science topics/concepts/skills included in this lesson, the teacher spontaneously mentioned (Check all that apply):

- ☐ They are included in the curriculum/textbook/test; s/he is expected/required to teach them
- ☐ They have always been taught in this grade/course
- ☐ They are important for kids to learn
- ☐ The students need knowledge of/exposure to these topics/concepts/skills for future units in this class/course
- ☐ The students need knowledge of/exposure to these topics/concepts/skills for future classes/courses

In the interview, the teacher was explicitly asked about state and district curriculum and assessments. Please summarize the information the teacher provided about each of the following, including quotes when appropriate, being sure to note particular influences on the selection of topics, instructional materials, and/or pedagogy for this lesson. Then rate the extent of influence of each.

ii. State and district curriculum standards/frameworks

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent ○ Not Applicable

iii. State and district science or mathematics tests/accountability systems/rewards and sanctions

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent ○ Not Applicable

iv. Textbook/program designated for this class

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent ○ Not Applicable

b. Support Infrastructure

In the interview, the teacher was asked about the professional development opportunities provided or encouraged by the district, as well as the influences of the principal, parents/community, school board, and other teachers in the school. Please summarize the information the teacher provided about each of the following, including quotes when appropriate, being sure to note particular influences on the selection of topics, instructional materials, and/or pedagogy for this lesson. Then rate the extent of influence of each.

i. Teacher professional development that is provided or encouraged by the district

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent ○ Not Applicable

ii. Principal

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

iii. Parents/community

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

iv. School board/district administration

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

v. Teacher collegiality (within the school/district)

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

c. Other Elements of the Policy and Support Infrastructure

In the interview, the teacher may have mentioned other aspects of the policy environment and support infrastructure. For each of the following that were mentioned, please summarize the information the teacher provided, including quotes when appropriate, being sure to note particular influences on the selection of topics, instructional materials, and pedagogy for this lesson. Then, rate the extent of the influence of each.

i. National standards documents ☐ Not mentioned

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

ii. School/district tracking/course assignment policies, including multi-age grouping and/or students remaining with the same teacher for multiple years ☐ Not mentioned

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

iii State and/or district tests of subjects other than the one observed ☐ Not mentioned

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

iv. School/district scheduling policies, including class length/block scheduling ☐ Not mentioned

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

v. Teacher evaluation system ☐ Not mentioned

Describe:
Rate the extent to which this aspect influenced the selection of topics/instructional materials/pedagogy for this lesson. ○ Not at all ○ Somewhat ○ To a great extent

2. The Physical Environment

We are defining the physical environment as including:

- Size and "feel" of the room, including what's on the walls;
- State of repair of classroom facilities;
- Appropriateness and flexibility of furniture;
- Availability of running water, electrical outlets, storage space; and
- Availability of equipment and supplies (including calculators and computers).

a. Describe the physical environment of this classroom.

b. Did the physical environment constrain the design and/or implementation of this lesson? (Circle one.)

Yes No Don't know

If yes, explain:

3. Instructional Materials

a. Which best describes the source of the **instructional materials** upon which this lesson was based? (Check one.)

- ○ Materials designated for this class/course, from a commercially published textbook/program
- ○ Materials designated for this class/course, developed by district, school, or other non-commercial source
- ○ Materials selected or adapted by the teacher, from a commercially published textbook/program
- ○ Materials selected or adapted by the teacher, from a non-commercial source
- ○ Materials developed by the teacher

b. Describe the textbook/program/instructional materials, including publisher, title, date, and pages if applicable. If the teacher made modifications to the instructional materials for this lesson, describe the modifications, why the teacher made these modifications, and the impact of the modifications on the quality of the lesson design.

4. Student Characteristics

a. Number of students:

i. Total in class: ____________
ii. For whom English is not their first language: _________
iii. With learning disabilities: ___________
iv. With other special needs: __________

b. Describe the ability level of students in this class compared to the student population in the school. (Check one.)

- ○ Represent the lower range of ability levels
- ○ Represent the middle range of ability levels
- ○ Represent the higher range of ability levels
- ○ Represent a broad range of ability levels

c. Teachers may consciously or unconsciously base their decisions on their perceptions of the characteristics of a particular group of students. Describe how the characteristics of the students in this class may have influenced the selection of topics/instructional materials/pedagogy for this lesson.

In this category, we include such factors as:

- Cognitive abilities
- Learning styles
- Prior knowledge
- Prior school experience
- Fluency with English
- Student attitudes towards science and mathematics
- Perceptions of utility of content
- Goals and aspirations
- Facility with class routines
- Student absenteeism/mobility
- Influence of parents
- Influence of peer culture

5. The Teacher

a. Number of years teacher has taught prior to this school year: ___________

b. In most situations, teachers have considerable latitude in making instructional decisions, and their decisions are often influenced by such factors as the teacher's:

- Knowledge of/attitudes toward/beliefs about the subject matter;
- Knowledge of/attitudes toward/beliefs about students as learners in general;
- Knowledge of/attitudes toward/beliefs about pedagogy;
- Pedagogical content knowledge/expertise; and
- Choices about professional development, conferences, networks.

Describe how the teacher's background knowledge, skills, and attitudes may have affected the selection of topics/instructional materials/pedagogy for this lesson.

c. If you think this lesson was very different from what is typical of this teacher's instruction in the class, check here ☐ and explain the likely differences and the evidence you have for them.

Section B. Why This Lesson?

In the previous section you considered separately how each of a number of factors (curriculum and assessment policies, supportive infrastructure, physical environment, instructional materials, student characteristics, teacher) may have influenced the selection of topics/instructional materials/pedagogy for this lesson. In this section, we would like you to consider how these various influences interacted, and highlight those which were most salient in determining why this lesson was taught and how it was designed. (Do not consider how well the design actually matched the students' needs, how well it was implemented, or your own judgement of the teacher's knowledge and skills. Rather, try to put yourself in the teacher's head—what s/he was thinking when planning this lesson. It would be appropriate to say "The teacher perceived himself as highly knowledgeable about…" or "The teacher indicated that the students already understood…" even if you have reason to believe that the teacher's perceptions are inaccurate.)

PART THREE: PUTTING IT ALL TOGETHER

We plan to use the data collected in this study to illustrate the status of mathematics and science education in the United States; to talk about the factors that affect the nature, substance, and quality of teaching practice in science and mathematics; and to understand how broadly and deeply "reform" has penetrated into science and mathematics classrooms. We will use narrative accounts (stories and vignettes) as devices to illustrate the nature of, quality of, and factors affecting science and mathematics lessons.

You have now had the opportunity to observe a lesson and also to find out what the teacher was thinking when s/he designed it. In this section, we ask you to "put it all together," highlighting "the story" of this lesson and providing a tag line that together communicate to us the narrative account that you would write about this lesson. We also ask you to assess the overall quality of the lesson, provide any additional information you would like to share about this lesson, and let us know if you think this lesson would make an interesting vignette.

1. **The Story of this Lesson**
   Summarize why this lesson was taught, why it looked the way it did, and how well it worked.

2. **Tag Line**
   Write a phrase or brief sentence that captures the essence of the story of this lesson.

3. **Overall assessment of the quality of the lesson in layperson's terms:**

   ______Bad
   ______Fair
   ______Good
   ______Very Good

4. **Additional Information**
   Use this space to write anything else you would like to say about this lesson, e.g., to suggest specific issues that may or may not be central to the story of this lesson, but illustrate a dilemma or issue particularly well.

5. **Recommendation**
   Check here if you would recommend that this lesson be considered for a vignette. ☐

LEADERS Participant Leadership Baseline Data

Part I. How much responsibility do you currently have for...

1. Organizing and facilitating professional learning communities for science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

2. Working with science educators to determine their professional learning needs.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

3. Designing customized professional learning opportunities and programs for other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

4. Coaching or mentoring other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

5. Being an advocate for science activities and strategies.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

6. Representing your school and district at professional meetings and conferences.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

7. Assessing the effectiveness of professional learning programs and processes for educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

8. Providing resources and research related to science reform to other educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

9. Working with scientists and industry partners.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

10. Involving parents and the community in enhancing science education

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

11. Providing energy-related content support to other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

Part II. How comfortable are you with...

1. Organizing and facilitating professional learning communities for science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with doing this?	❑	❑	❑	❑	❑

2. Working with science educators to determine their professional learning needs.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with doing this?	❑	❑	❑	❑	❑

3. Designing customized professional learning opportunities and programs for other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le

How comfortable are you with doing this?	❑	❑	❑	❑	❑

4. Coaching or mentoring other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with doing this?	❑	❑	❑	❑	❑

5. Being an advocate for science activities and strategies.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

6. Representing your school and district at professional meetings and conferences.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

7. Assessing the effectiveness of professional learning programs and processes for educators.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

8. Providing resources and research related to science reform to other educators.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

9. Working with scientists and industry partners.

	Very comfortable	Comfortable	Neutral	Uncomfortab le	Very uncomfortab le
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

10. Involving parents and the community in enhancing science education

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

11. Providing energy-related content support to other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

Part III. Knowledge & Skills

1. I am knowledgeable about project-based science.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

2. I am knowledgeable about inquiry-based teaching methods.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

3. I am knowledgeable about the needs of science teachers in my school.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

4. I am knowledgeable about the needs of science teachers in my district.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

5. I am knowledgeable about the needs of policy makers (e.g., superintendents, government officials, etc).

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

6. I am knowledgeable about current educational issues

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

7. I am knowledgeable about the National Science Education Standards.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

8. I am knowledgeable about the Ohio Science Standards.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

9. I have the knowledge and skills to write curriculum about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

10. I have the knowledge and skills to help new teachers understand and teach about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

11. I have the knowledge and skills to help experienced teachers understand and teach about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

12. I have the knowledge and skills to design and provide professional development to experienced teachers about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

13. I have the knowledge and skills to discuss education-related policies with policy makers (e.g., superintendents, government officials, etc.)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

14. I have the knowledge and skills to discuss educational research with science education researchers.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

LEADERS Participant Leadership Baseline Data

Part I. How much responsibility do you currently have for...

1. Organizing and facilitating professional learning communities for science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

2. Working with science educators to determine their professional learning needs.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

3. Designing customized professional learning opportunities and programs for other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

4. Coaching or mentoring other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

5. Being an advocate for science activities and strategies.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

6. Representing your school and district at professional meetings and conferences.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

7. Assessing the effectiveness of professional learning programs and processes for educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❑	❑	❑	❑	❑

8. Providing resources and research related to science reform to other educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❏	❏	❏	❏	❏

9. Working with scientists and industry partners.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❏	❏	❏	❏	❏

10. Involving parents and the community in enhancing science education

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❏	❏	❏	❏	❏

11. Providing energy-related content support to other science educators.

	A great deal	A moderate amount	Some	Very little	None
How much responsibility do you currently have for doing this?	❏	❏	❏	❏	❏

Part II. How comfortable are you with...

1. Organizing and facilitating professional learning communities for science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with doing this?	❏	❏	❏	❏	❏

2. Working with science educators to determine their professional learning needs.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with doing this?	❏	❏	❏	❏	❏

3. Designing customized professional learning opportunities and programs for other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable

How comfortable are you with doing this?	❑	❑	❑	❑	❑

4. Coaching or mentoring other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with doing this?	❑	❑	❑	❑	❑

5. Being an advocate for science activities and strategies.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

6. Representing your school and district at professional meetings and conferences.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

7. Assessing the effectiveness of professional learning programs and processes for educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

8. Providing resources and research related to science reform to other educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

9. Working with scientists and industry partners.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

10. Involving parents and the community in enhancing science education

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable

How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

11. Providing energy-related content support to other science educators.

	Very comfortable	Comfortable	Neutral	Uncomfortable	Very uncomfortable
How comfortable are you with carrying out this responsibility?	❑	❑	❑	❑	❑

Part III. Knowledge & Skills

1. I am knowledgeable about project-based science.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

2. I am knowledgeable about inquiry-based teaching methods.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

3. I am knowledgeable about the needs of science teachers in my school.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

4. I am knowledgeable about the needs of science teachers in my district.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

5. I am knowledgeable about the needs of policy makers (e.g., superintendents, government officials, etc).

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

6. I am knowledgeable about current educational issues

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

7. I am knowledgeable about the National Science Education Standards.

	Strongly	Agree	Neutral	Disagree	Strongly

	Agree				Disagree
	❑	❑	❑	❑	❑

8. I am knowledgeable about the Ohio Science Standards.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

9. I have the knowledge and skills to write curriculum about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

10. I have the knowledge and skills to help new teachers understand and teach about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

11. I have the knowledge and skills to help experienced teachers understand and teach about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

12. I have the knowledge and skills to design and provide professional development to experienced teachers about energy issues.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

13. I have the knowledge and skills to discuss education-related policies with policy makers (e.g., superintendents, government officials, etc.)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑

14. I have the knowledge and skills to discuss educational research with science education researchers.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	❑	❑	❑	❑	❑