KIDS CONSORTIUM

Integrating Scientific Practices and Service-Learning:

Engaging Students in STEM

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Founded in 1992, KIDS (Kids Involved Doing Service-Learning) Consortium is a nonprofit organization that strengthens service-learning collaborations by preparing and connecting students, educators, and community partners. Service-learning is a hands-on teaching strategy that challenges young people to work with community partners, applying academic knowledge and skills to solve real problems and needs. Through service-learning, young people gain the essential problem-solving, communication and teamwork skills needed to address complex issues in their communities and succeed in a competitive global workforce. Over the past two decades, KIDS has engaged more than 250,000 K-12 students in service-learning experiences that led to increases in academic and civic engagement and connectedness to school and community (a resiliency measure).

KIDS Consortium Offers:

- **Professional Development**

  ...to help educators become effective service-learning practitioners. Our programs include introductory awareness sessions, one- and two-day workshops, and in-depth summer institutes.

  ...to help schools integrate service-learning into the curriculum.

  ...to help community partners develop and implement strategies to engage schools and young people to address issues of mutual concern.

- **Customized Services** developed collaboratively and tailored to meet the needs of schools, school districts, state and regional agencies, colleges of education, and community organizations (e.g., in-service and pre-service workshops, coaching sessions, and strategic planning processes).

- **Books and Resources** offering step-by-step guidance and ideas for service-learning projects. Its premier publication, KIDS as Planners: A Guide to Strengthening Students, Schools and Communities through Service-Learning (revised and expanded in 2011), is an essential complement to this guide.

- **Connections** to a service-learning network through our KIDS e-newsletter, Facebook, Twitter, blog, and YouTube.

- **Grants** to schools and community organizations working to integrate and sustain service-learning.

- **Events** that bring together students, teachers, and community partners to share successes and learn new skills.

Maine MATHEMATICS and SCIENCE Alliance

www.mmsa.org

Maine Mathematics and Science Alliance (MMSA) supports science and mathematics education in Maine and across the country through its programs, staff, fee for service, and a diverse portfolio of grant-funded projects in science, technology, engineering, and mathematics (STEM) education. MMSA has provided leadership, resources, and professional development support to K-12 educators since 1992, and is known for translating research and educational standards into effective teaching and learning practice statewide and across the nation.

MMSA Professional Development and Consulting Services include:

- **Curriculum Topic Study (www.curriculumtopicstudy.org):** Learn how to use a comprehensive resource that enables teachers to examine all aspects of math and science topics they teach and to bridge the gap between standards, research, and classroom practice.
- **Formative Assessment in Science:** Learn how to use formative assessment strategies to identify students' ideas, diagnose difficulties, inform instructional practice, and monitor student learning in mathematics and science.
- **Consulting** provided in the areas of integrating inquiry science and language literacy, curriculum analysis or implementation, instructional design, teaching and learning strategies, examining student work and thinking, and embedded professional development planning. For more information, visit www.mmsa.org.

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A Note Concerning Copyright

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Opinions or points of view expressed in this document are those of the authors and do not necessarily reflect the position of the Corporation for National and Community Service.

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"The data piece is new for me and I found that students really enjoy trying to figure out what it all means. Students used data to investigate the problems and to determine where they should focus their efforts. Having data to share helped validate what the students were doing (especially when they presented their concerns to others). I love to see the excitement and enthusiasm that these projects create in my classroom, school, and community. Service-learning provides a rich opportunity for students to really make a difference and to learn real-life skills they will use as adults."

- Bonnie Burne, Pemetic Elementary School, Southwest Harbor, Maine

Acknowledgments

KIDS Consortium and the Maine Mathematics and Science Alliance acknowledge the staff and students at the following schools who participated in the Youth as Citizen Scientists initiative, and graciously shared their experiences and insights. Many of the teachers who participated were new to both service-learning and Curriculum Topic Study, yet they demonstrated their own commitment to lifelong learning by taking on new roles in the classroom, extending their knowledge of curriculum development, and modeling an exciting new instructional strategy for their peers.

Ashland District School, Ashland, ME
..... (http://www.sad32.org/ashland-district-school.html)

Crossett Brook Middle School, Duxbury, VT
..... (https://sites.google.com/a/wdsdvt.net/cbms/)

Myers Middle School, Albany, NY
..... (http://www.albanyschools.org/schools/myersmiddle/myers.htm)

Lincoln Middle School, Portland, ME
..... (http://www2.portlandschools.org/schools/middle-schools/lincoln-middle-school)

Lisbon Central School, Lisbon, CT
..... (http://www.lisboncentralschool.com/)

North Albany Academy, Albany, NY
..... (http://www.albanyschools.org/schools/northalbany/nrthalb.htm)

Pemetic Elementary School, Southwest Harbor, ME
..... (http://www.mdirss.org/)

Presque Isle Middle School, Preque Isle, ME
..... (http://www.sad1.org/pims/)

Roosevelt Middle School, New Bedford, MA
..... (http://www.newbedford.k12.ma.us/roosevel.htm)

Hackett Middle School, Albany, NY
..... (http://www.albanyschools.org/schools/hackettmiddle/hackett.htm)

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"Students became more aware of how scientists play an important role, and how it's valuable to do science rather than just read about it."

- Saozinha deOliveira, Roosevelt Middle School, New Bedford, Massachusetts

Introduction

"Never before have the stakes been so high for the role of science education in shaping how people interact with the environment."

— Organisation for Economic Co-operation and Development, 2009

In an increasingly complex world facing major challenges related to energy, transportation, public health, and the environment, students must learn to be creative problem-solvers who can analyze and act on information; think critically; tackle multidisciplinary challenges; and engage fully in civic life. Many American schools are working to revitalize the teaching of science, technology, engineering and math (STEM) to better prepare students for the demands of the 21-century. Scientific and mathematical literacy are essential to understand contemporary challenges and constructively shape the nation's future.Yet an estimated 80 percent of American students are not proficient in STEM fields and in a 2009 test (OECD Programme for International Student Assessment) measuring international academic performance, American students ranked 17th in science and 25th in mathematics.

"We're constantly fighting a relevance battle, and that's something we need to think about for all subjects. Students need to feel like what they're learning will help them down the road."

— Stephen Bowen, Maine Commissioner of Education (September 2011, quoted in the Bangor Daily News)

The science education community is addressing this critical problem with the development of new K-12 science standards (see www.nextgenscience.org), due to be finalized in 2012. The standards being created are based on the National Research Council's Framework for K–12 Science Education (http://www7.nationalacademies.org/bose/Standards_Framework_Homepage.html), which emphasizes that students should use scientific practices to learn more about core ideas. Service-learning can help schools meet these new standards by encouraging students to address real-world problems that require STEM skills, helping them become "citizen scientists."

Service-learning is an instructional strategy that goes beyond community service and community-based learning, and links directly to standards-based curriculum—helping students meet or exceed standards while engaging in meaningful, relevant projects that benefit their community. Students gain the skills and confidence that 21st-century work will require, and develop a sense of personal efficacy and a commitment to lifelong learning.

"My seventh-grade students are doing a service-learning project, applying their new knowledge and skills to test water quality and decide whether to release native salmon into a local stream. This unit, which I have taught for many years, has come to life. The kids are using what they have learned in class to help solve a real problem in their community."

— Stephen Brown, Lisbon Central School, Lisbon, Connecticut

This guide, a supplement to the more comprehensive KIDS As Planners: A Guide to Strengthening Students, Schools and Communities through Service-Learning (see inside front cover or visit www.kidsconsortium.org), is designed to help you integrate service-learning into STEM content areas and make use of Curriculum Topic Study (CTS), a valuable means of ensuring that STEM projects are developmentally appropriate and aligned with science standards. Examples in this guide, based on the experience of more than a dozen classrooms, help illustrate how to plan and structure a STEM/service-learning project and how these projects benefit students, schools and communities.

Project Overview

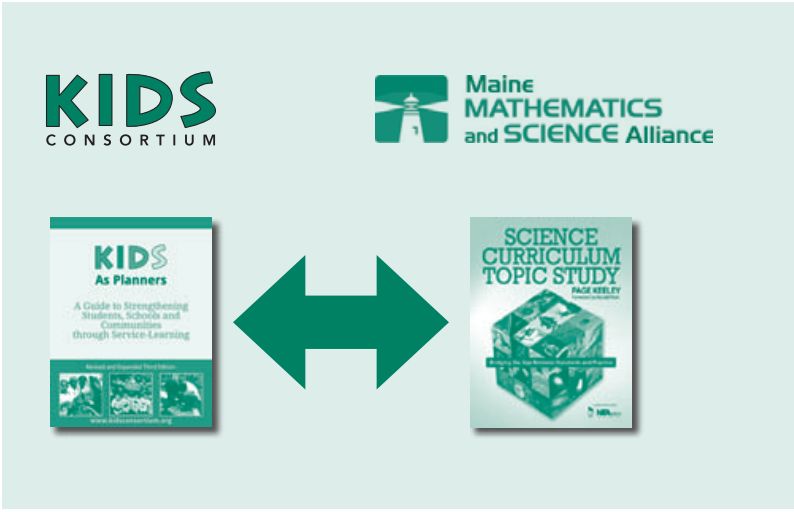
This guide grew out of the Youth as Citizen Scientists (YACS) initiative in which more than 1,000 middle-school students at 10 sites across New England and New York worked with their teachers and community partners to address environmental issues (such as waste reduction and energy efficiency) in their schools. The projects followed the KIDS Consortium Framework for service-learning and research-based practices in STEM (science, technology, engineering and math) to help students learn essential STEM content and skills, and improve their ability to collaborate, communicate and solve problems.

The YACS initiative, a collaboration between KIDS Consortium (KIDS) and the Maine Mathematics and Science Alliance (MMSA), was funded through a grant from the Corporation for National and Community Service for a Learn and Serve America Competitive School-Based Grant for Service-Learning. KIDS and MMSA consultants provided professional development support over two years to help teachers implement high-quality service-learning projects within STEM disciplines. Participating teachers included both experienced service-learning practitioners and those fairly new to service-learning.

While STEM projects span a wide range of topics, participating teachers in the YACS initiative received grant funding and professional development to conduct "Green School" projects that met the following criteria:

- deepen understanding of science practice and concepts;
- collect, analyze,
- interpret and share data;
- use data to demonstrate problem and show impact;
- reduce school consumption of non-renewable resources;
- provide a product or service for a real audience;
- consider lasting impact;
- and enact KIDS principles and include all aspects of the KIDS Framework.

The examples listed in this guide reflect their emphasis on in-school projects. However, STEM projects often involve the larger community.



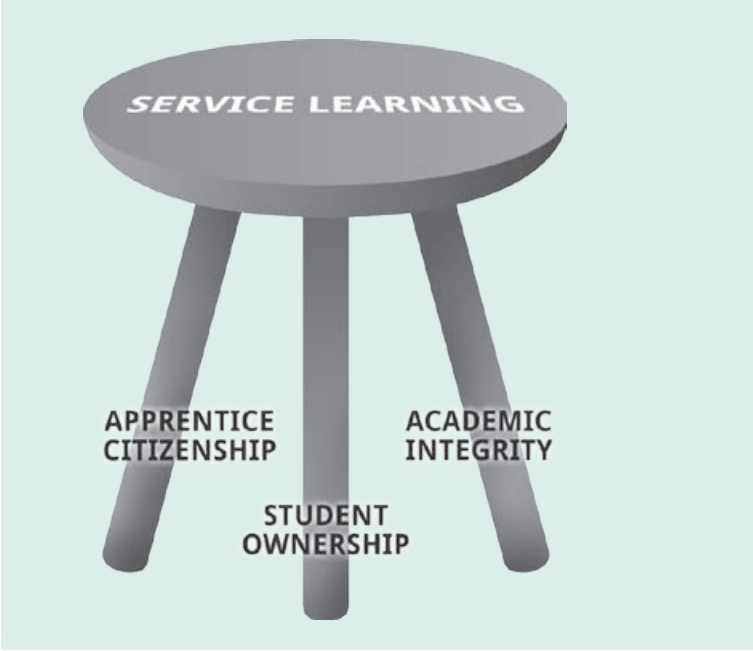
"I've observed students present on their STEM/service-learning projects six months after they ended and their recall and ability to articulate what they learned is remarkable. They clearly retained all the content they absorbed and could transfer it to other situations—a sign of true learning!"

— Tracy Harkins, Educational Programs Manager, KIDS Consortium

Project Approaches

Principles and Framework of Service-Learning

Three key principles underlie the KIDS service-learning model and shape the success of each project: academic integrity, apprentice citizenship and student ownership. Already busy with existing demands, educators cannot afford to take on "yet another thing" to teach. Service-learning helps students meet national and state standards and achieve measurable outcomes while fostering meaningful learning experiences (for both students and teachers). As students develop expertise in community issues and collaborate in problem-solving, they develop the civic skills needed for effective citizenship—such as cooperation, advocacy and negotiation. Projects involving "real life" concerns can motivate students at all levels, engaging those who don't respond well to traditional classroom approaches and encouraging high-ability students to reach beyond the set curricula. Students gain confidence and often demonstrate unprecedented creativity and responsibility.



The KIDS Framework (see page 4 and Appendix B) demonstrates how to translate these principles into a process that will help you implement a valuable service-learning experience. Through its step-by-step Framework and three core principles, the KIDS service-learning model can help you achieve national K-12 Service-Learning Standards for Quality Practice (see following chart). For a detailed overview of these national standards, visit the National Youth Leadership Council website (www.nylc.org/k-12-service-learning-standards-quality-practice). The emphasis on academic integrity in KIDS projects also helps students achieve or exceed national benchmarks and standards for STEM subjects, as outlined in the next section.

KIDS Framework

The following figure depicts the steps that KIDS service-learning projects typically involve.

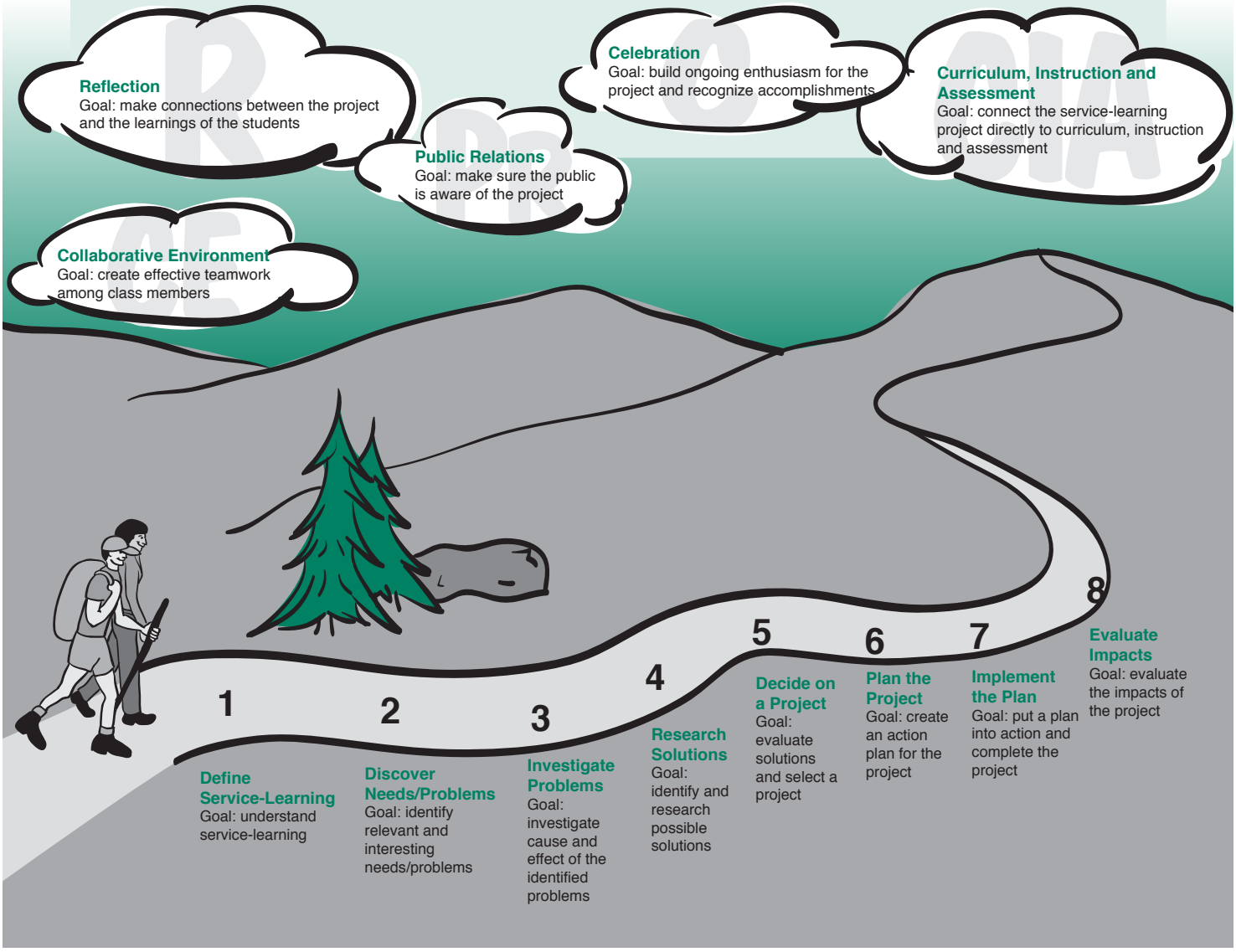
1. define service-learning;
2. discover needs and problems;
3. investigate problems;
4. research solutions;
5. decide on a project;
6. plan the project;
7. implement the plan; and
8. evaluate impacts.

Following these steps can help ensure that your project is well-planned and carefully executed. All of the steps should be completed, but their scope and sequence may vary depending on the nature of the project.

As you follow these steps, do not lose sight of the Framework's "clouds:"

- collaborative environment;
- reflection;
- public relations;
- celebration; and
- curriculum, instruction and assessment.

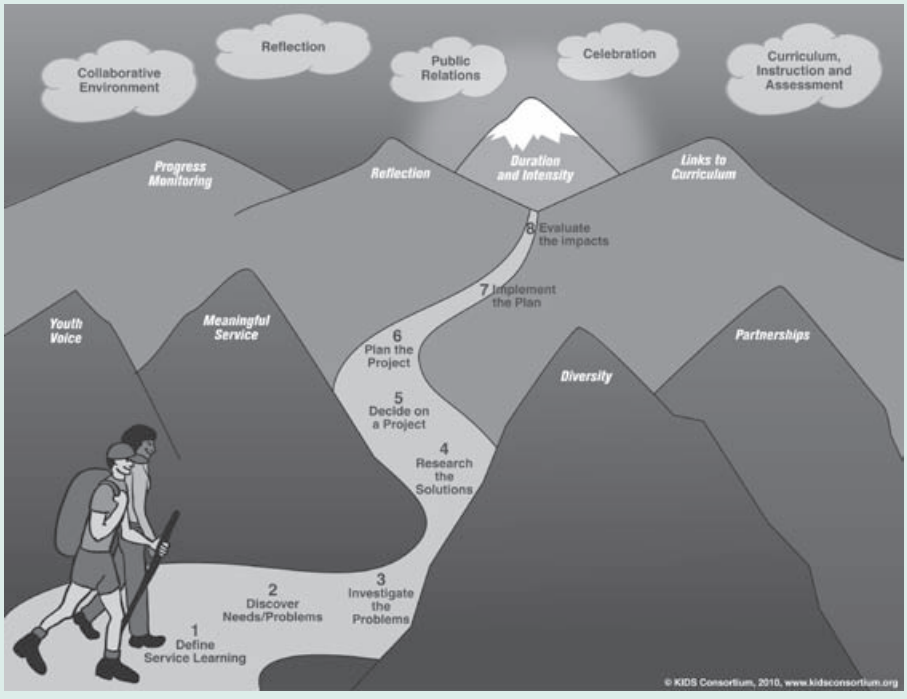
These concepts are essential elements of all KIDS service-learning projects that happen on an ongoing basis throughout the process, and can be adapted to meet the needs of individual projects. Pay continual attention to them as you follow the Framework steps. A blank framework planning sheet can be found in the Appendix on page 44.



How the KIDS Framework Helps Meet K-12 National Service-Learning Standards

Where the KIDS Framework helps to meet standards	K-12 National Standards
STUDENTS: ▶ work w/ community partners throughout the framework ▶ discover relevant and interesting needs/problems ▶ investigate the cause and effect of problems on all stakeholders ▶ research multiple solutions before deciding on best option ▶ plan and implement a solution ▶ develop effective teamwork and collaboration skills to foster mutual respect and multiple perspectives	**YOUTH VOICE** **PARTNERSHIPS** **MEANINGFUL SERVICE** **DIVERSITY**
STUDENTS: ▶ demonstrate curriculum objectives and engage in direct and independent instruction and multiple forms of assessment ▶ engage in multiple reflection activities to connect project experiences and learning (affective and cognitive) ▶ communicate the project's progress to others to build public relations ▶ celebrate to build ongoing enthusiasm for the project and recognize accomplishments ▶ evaluate the impacts of the project on the specified problem/need	**LINKS TO CURRICULUM** **PROGRESS MONITORING** **REFLECTION**
Meeting the goals of each of the framework steps will ensure that community and student outcomes are met. Sufficient time must be devoted to implementing the steps of the framework for the integrity of the process to be upheld.	**DURATION & INTENSITY**

www.nylc.org/standards

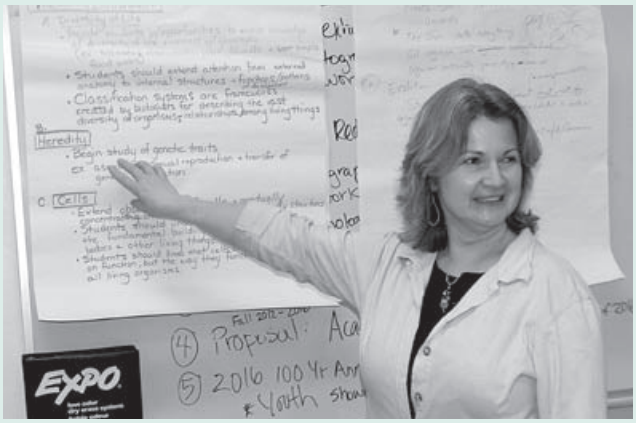


Using Curriculum Topic Study (CTS) to Enhance STEM Instruction

The efforts underway to reform science education assume that schools should not be asked to cover more and more content, but rather should focus on what's essential to scientific literacy and teach that more effectively. Teachers need to know what to teach, why to cover particular material, and how to teach it in a developmentally appropriate manner. Curriculum Topic Study (CTS) offers a critical tool to meet these needs, being a systematic process that helps teachers make effective use of the standards and research on student learning. CTS has proven to be an intellectually engaging professional development experience for many teachers, clarifying their understanding of relevant curricular topics and their students' needs.

Funded in part by the National Science Foundation, CTS resources (see page 9 and curriculumtopicstudy.org) help K-12 teachers better understand the what, why and how of the science topics they teach. There are currently 147 CTS guides in the manual Science Curriculum Topic Study: Bridging the Gap Between Standards and Practice (by Page Keeley, Corwin Press, 2005), representing a range of content- and skill-based topics across different scientific disciplines. Each CTS guide uses a standard template divided into six sections:

- **I** identify adult content knowledge;
- **II** consider instructional implications;
- **III** identify concepts and specific ideas;
- **IV** examine research on student learning;
- **V** examine coherency and articulation; and
- **VI** clarify state standards and district curriculum.



"This project showed me the tremendous impact that students can have when they apply science (STEM) concepts from class to a real-world situation. CTS helped me look deeper into the concept of electricity and efficiency to see how I could use simple science concepts such as energy transformation and circuits to achieve the big picture for my students—and meet curriculum requirements involving resource consumption, electricity and renewable energy and efficiency. Many of my students felt that they really learned science, and made a difference in their future and the future of others."

— Wendy Moore, Crossett Brook Middle School, Duxbury, Vermont

ANATOMY OF A SCIENCE CTS STUDY GUIDE

Section I. Identify Adult Content Knowledge- This section helps users identify what all science literate adults (including teachers) should know about science as well as what all students should know at the end of their high school education. It also provides content explanations for science or mathematics ideas encountered in the media, public issues, and other popular science venues in which an adult understanding of science is important.

Section II. Consider Instructional Implications- This section helps users identify important considerations for K-12 or grade span instruction. It provides a broad overview of the ideas to be learned, including grade level pacing and difficulties, and suggests contexts and opportunities that foster learning.

Section III. Identify Concepts and Specific Ideas- This section helps users identify the learning goals, the specific concepts and ideas in a learning goal, their level of sophistication, and the appropriate terminology to be used at different grade levels.

Section IV. Examine Research on Student Learning- This section identifies related research so that users can examine developmental considerations, possible misconceptions and their sources, intuitive ideas, types of reasoning used by students, and difficulties encountered by in understanding scientific ideas.

Section V. Examine Coherency and Articulation (and more)- This section helps users examine the K-12 conceptual growth in understanding as a coherent flow of ideas build in sophistication over time. It helps identify important prerequisites for learning, and connections between ideas within and across topics. The narrative on the page preceding an Atlas map also enhances the overview and grade span implications in **Section IIA.** Both volumes of the Atlas provide research notes that can also be used with **Section IVA**. Atlas Vol 2 extends the research available in *Benchmarks* Chapter 15 by including more recent research available after the *Benchmarks* were published in 1994.

The right hand side of a CTS guide, titled "**Selected Sources and Readings for Study and Reflection**," includes the selected readings from the CTS common set of resources for study and reflection that correspond to each of the outcomes, I-VI. Each section provides two choices of source material (A or B choices). Depending upon availability and the CTS guide selected, users may choose to read sections from both choices of source material, or choose to use only one.

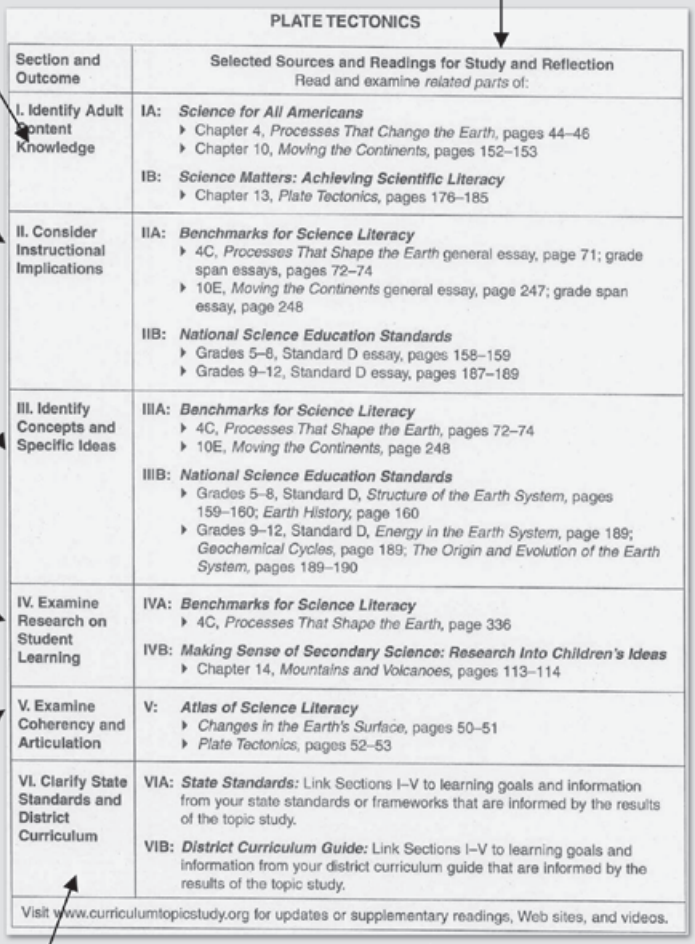


PLATE TECTONICS

Section and Outcome	Selected Sources and Readings for Study and Reflection Read and examine *related parts* of:
I. Identify Adult Content Knowledge	IA: ***Science for All Americans*** ▸ Chapter 4, *Processes That Change the Earth*, pages 44–46 ▸ Chapter 10, *Moving the Continents*, pages 152–153 IB: ***Science Matters: Achieving Scientific Literacy*** ▸ Chapter 13, *Plate Tectonics*, pages 176–185
II. Consider Instructional Implications	IIA: ***Benchmarks for Science Literacy*** ▸ 4C, *Processes That Shape the Earth* general essay, page 71; grade span essays, pages 72–74 ▸ 10E, *Moving the Continents* general essay, page 247; grade span essay, page 248 IIB: ***National Science Education Standards*** ▸ Grades 5–8, Standard D essay, pages 158–159 ▸ Grades 9–12, Standard D essay, pages 187–189
III. Identify Concepts and Specific Ideas	IIIA: ***Benchmarks for Science Literacy*** ▸ 4C, *Processes That Shape the Earth*, pages 72–74 ▸ 10E, *Moving the Continents*, page 248 IIIB: ***National Science Education Standards*** ▸ Grades 5–8, Standard D, *Structure of the Earth System*, pages 159–160; *Earth History*, page 160 ▸ Grades 9–12, Standard D, *Energy in the Earth System*, page 189; *Geochemical Cycles*, page 189; *The Origin and Evolution of the Earth System*, pages 189–190
IV. Examine Research on Student Learning	IVA: ***Benchmarks for Science Literacy*** ▸ 4C, *Processes That Shape the Earth*, page 336 IVB: ***Making Sense of Secondary Science: Research Into Children's Ideas*** ▸ Chapter 14, *Mountains and Volcanoes*, pages 113–114
V. Examine Coherency and Articulation	V: ***Atlas of Science Literacy*** ▸ *Changes in the Earth's Surface*, pages 50–51 ▸ *Plate Tectonics*, pages 52–53
VI. Clarify State Standards and District Curriculum	VIA: ***State Standards:*** Link Sections I–V to learning goals and information from your state standards or frameworks that are informed by the results of the topic study. VIB: ***District Curriculum Guide:*** Link Sections I–V to learning goals and information from your district curriculum guide that are informed by the results of the topic study.

Visit www.curriculumtopicstudy.org for updates or supplementary readings, Web sites, and videos.

Optional Topic Specific Supplements: At the bottom of each study guide is a link to the **CTS web site**, where users can access the CTS database to find optional readings and media resources to supplement individual CTS guides.

Section VI. Clarify State Standards and District Curriculum- This section helps the user clarify the meaning and intent of their own state standards or learning goals in their district curriculum by taking the previous five sections and linking the information to the context the user works in. It also helps the user identify important, key ideas in science that may be missing at the state or local level, which should be addressed along with their standards.

Project Profile: Recycling Paper

During study units on energy, the conservation of matter, and sustainability, middle school science students at the Ashland District School in Ashland, Maine undertook a project designed to lower the amount of paper waste their school generated. They sought to make their school "greener" by encouraging reuse of renewable resources. Working with STEM principles helped their teacher ground the project work in the science curriculum: "CTS enlightened me directly on what my students needed to have," observes Tricia Bragan, "and at what level they needed to understand it."

Students began with a discussion of service-learning and gained comfort with the concept by playing the KIDS Consortium What Is It? Game (KIDSconsortium.org/games.php). After watching several documentaries (such as Garbage: the Revolution Starts at Home and Human Footprint) and attending an annual "Energy Education Extravaganza," students began to research ways they could reduce waste within their school.

Students designed a school-wide survey so they could gain more information about student and teacher habits and current obstacles to reducing waste. After reviewing more than 100 responses, they realized that their school had only 5 recycling bins. They spent five weeks weighing and charting the volume of paper collected in those bins. The students theorized that more bins would make recycling more convenient and increase the volume of paper that was recycled. They ordered more bins and then—to evaluate the impact of the new bins—tracked paper volumes for another five weeks. As they had anticipated, the volume of recycled paper did increase.

Students discovered paper recycle bins were being used for garbage and it was clear they needed to educate the school community about recycling and the importance of separating materials. Students visited classrooms to talk about the 3 Rs (reduce, reuse, recycle), helping reinforce their understanding of the energy curriculum by explaining the concept of recycling to others. The local paper featured their project in a cover story, showing a photo of the middle school students reading to first graders.

The school community was receptive and began inviting the students to help with other recycling challenges—such as composting food waste and grass clippings. "The students felt proud knowing their initial work had been received positively and that people were coming to them asking for help," reflects Bragan. "At the end of the school year, the students began researching composter bins." For Bragan, the project affirmed the importance of student engagement and the long-term value of service learning: "I feel a great need to include student questions and observations into regular planning and implementing of lessons as these will be the ones they remember."

Resources for STEM Curriculum Topic Study

Teachers in the YACS initiative relied primarily on Science Curriculum Topic Study: Bridging the Gap Between Standards and Practice (by Page Keeley, Corwin Press, 2005) to guide them to additional standards- and research-based resources on student learning, listed below (please reference CTS description on page 7). Most of these national resources are available online (see the URLs listed).

CTS Section I Resources: Science for All Americans and/or Science Matters

American Association for the Advancement of Science. (1990). Science for All Americans. New York, NY: Oxford University Press. To view online, go to http://www.project2061.org/publications/sfaa/online/sfaatoc.htm.

Hazen, R. and Trefil, J. (2009). Science Mmatters; Achieving Scientific Literacy. New York, NY: Anchor Books. Not available as a download online but available through bookstores. The original edition was published in 1991, with an updated and expanded edition reissued in 2009.

CTS Sections II and III Resources: Benchmarks for Science Literacy and National Science Education Standards

American Association for the Advancement of Science. (1994). Benchmarks for Science Literacy. New York, NY: Oxford University Press. The updated 2009 edition of Benchmarks is available online in the "Quick Links" section of the Project 2061 web site at http://www.project2061.org/.

National Research Council (1996). National Science Education Standards. Washington DC: National Academy Press. A copy can be viewed online at the National Academy Press site, http://www.nap.edu/openbook.php?record_id=4962. Note: When released in 2012, the Next Generation Science Standards will replace the National Science Education STandards in CTS. A crosswalk to the new standards will be available for all CTS topics.

CTS Section IV Resources: Chapter 15 of the Benchmarks for Science Literacy and Making Sense of Secondary Science

American Association for the Advancement of Science. (1994). Benchmarks for Science Literacy. NY, NY: Oxford University Press. The updated 2009 edition of Benchmarks is available online in the "Quick Links" section of the Project 2061 web site at http://www.project2061.org/.

Driver, R., et. al. (1994). Making Sense of Secondary Science: Research into Cchildren's Ideas. NY, NY: Routledge Press. Not available online but can be ordered through bookstores.

CTS Section V: Atlas of Science Literacy Volumes 1 and 2

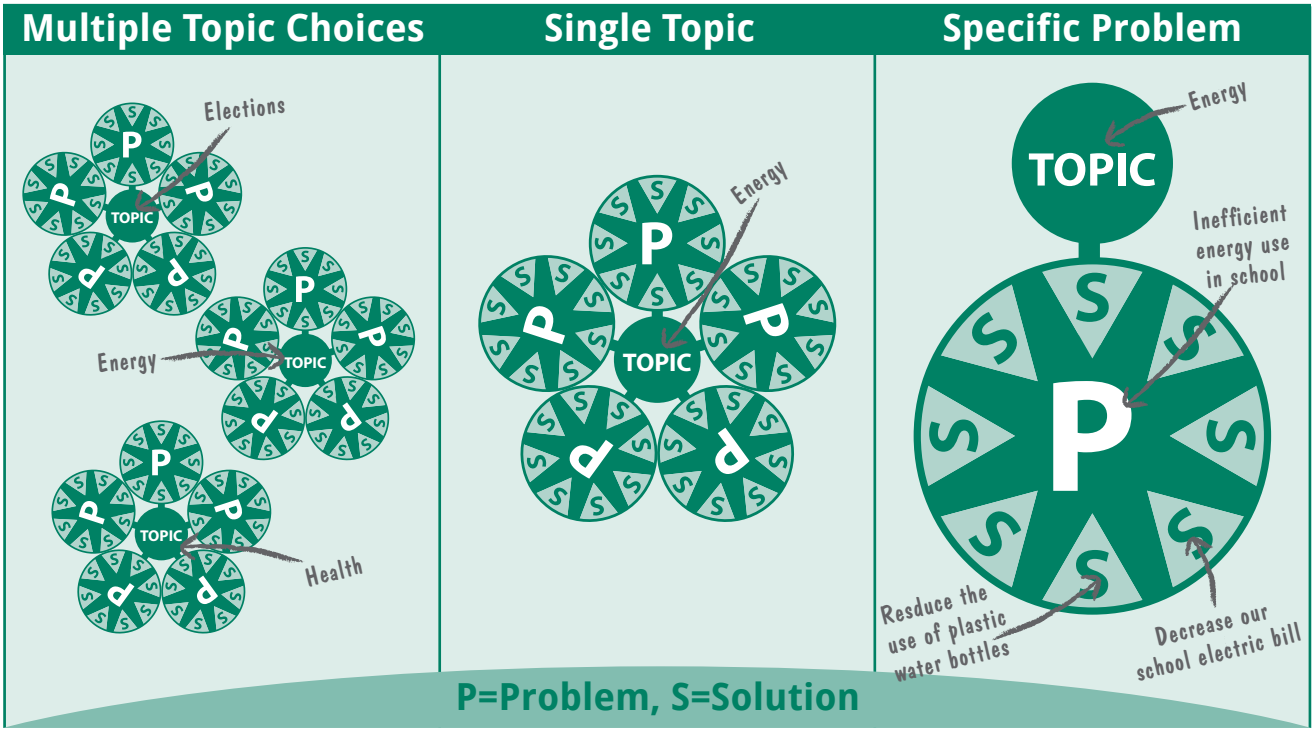
American Association for the Advancement of Science. (2001). Atlas of Science Literacy- Volume 1. Washington DC: NSTA Press. Sample maps and ordering information available on the Project 2061 website, http://www.project2061.org/.

American Association for the Advancement of Science. (2007). Atlas of Science Literacy- Volume 2. Washington DC: NSTA Press. [Note: The second volume of Atlas was not available at the time CTS was published and is not included in the CTS study guides. You can download the Crosswalk to the Atlas of Science Literacy to obtain vetted readings from both versions of the Atlas.] Sample maps and ordering information are available on the Project 2061 website, http://www.project2061.org/

Link Projects to the Curriculum

As you consider options for STEM/service-learning, you might start by identifying a science topic in your curriculum (such as ecosystems or health and disease in life science; conservation of matter or energy transformation in physical science; or weathering/erosion or air and atmosphere in earth science.) A CTS inquiry can help you identify contemporary problems/needs related to that topic. You'll want to decide whether students will explore multiple problems/needs under one topic or focus on a single problem. For more information about these entry points into a service-learning project, see page 20 in KIDS as Planners Guidebook.

ENTRY POINTS



While you can develop many service-learning projects with multiple, direct ties to your curriculum (as the following section illustrates), there may be study units (such as astronomy) that do not offer an appropriate scale problem for service-learning or that students do not find compelling concern. In those cases, it's best not to force-fit service-learning into the curriculum.

Examples of "Green School" Service-Learning Projects

Science topics: Conservation of Energy; Energy; Energy Transformation; Energy Resources and Use; Data Collection & Analysis; Science as Inquiry.

Problem: Inefficient Energy Use in School Buildings

Solutions Students Developed:

- Conduct audit to identify where energy is being wasted and educate others on these wastes
- Replace inefficient lightbulbs and exit signs
- Reduce unnecessary lighting
- Replace paper towels with high-efficiency hand dryers
- Educate others about saving energy through events, videos, announcements, posters

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Science topics: Water Cycle; Soil; Weathering and Erosion; Air and Atmosphere; Earth's Natural Resources; Decomposers and Decay; Conservation of Matter; Interdependency among Organisms; Human Impact on the Environment; Flow of Energy through Ecosystems; Cycling of Matter in Ecosystems; Data Collection & Analysis; Science as Inquiry.

Problems: Waste of non-renewable resources; careless disposal of renewable resources; air/water and soil pollution from excessive waste generation and poor waste management; water and soil runoff/ erosion issues from changes in land use.

Solutions Students Developed:

- Establish or expand school- and community-based recycling and reduce use of disposables (e.g., paper, plastic, cans, metal, cell phones and inkjet/toner cartridges)
- Raise school awareness about the ecological and economic costs of using disposable products (e.g., polystyrene trays) and discarding recyclable materials
- Convert to reusable trays and metal cutlery in the cafeteria (eliminating polystrene trays)
- Raise money to create a swap shop at the local transfer station for reusable items
- Increase number of recycling bins in schools and educate students and staff about their use
- Establish a "no polystyrene" policy (and help cafeteria staff find alternative suppliers)
- Establish a school composting program (outdoor or worm bin system) for food and/or yard/garden waste (and educate community about the importance of participation)
- Establish a school garden
- Organize a collection drive (and related media outreadh) for electronic waste
- Teach younger students about the need to "reduce, reuse and recycle"
- Organize school-wide competitions to encourage waste reduction
- Raise funds, purchase, and distribute reusable stainless water bottles
- Make reusable lunch wraps to reduce use of plastic sandwich bags

Science topics: Personal and Community Health; Health and Disease; Risks and Benefits of Science and Technology; Water Cycle; Soil; Earth's Natural Resources; Conservation of Matter; Interdependency among Organisms; Human Impact on the Environment; Flow of Energy through Ecosystems; Cycling of Matter in Ecosystems; Data Collection & Analysis; Science as Inquiry.

Problems: School environment and local community do not always foster healthy and sustainable living (e.g, spread of germs, lack of outdoor experiences; unhealthy and unappealing cafeteria food; potentially hazardous cleaners; diminished water quality in nearby brooks; roadside trash in community; lack of awareness about healthy/sustainable living).

Solutions Students Developed:

- Reduce spread of pathogens in school at cafeteria tables and water fountains
- Encourage healthier cafeteria foods and urge students to eat what they take
- Adopt use of environmentally safe cleaners
- Analyze and improve water quality in nearby waterways
- Collect and analyze roadside trash and survey businesses concerning takeout containers
- Promote school's outdoor classroom (geodesic dome and gardens) to other students and staff
- Organize an Earth Day celebration
- Promote reduced carbon emissions (through a community pledge, placemats at area restaurants, etc.)

Full length profiles of many of these projects can be found on the KIDS Consortium website at www.kidsconsortium.org.

When you have completed a CTS on a science topic in your curriculum and brainstormed possible problems that your students might explore, you're ready to introduce that unit to students. In the YACS initiative, teachers often used their CTS summary to inform design of the project (as in the following example, where a study on Conservation of Matter helped shape a class investigation of cafeteria waste at the school).

Sample CTS Summary:

Conservation of Matter

Section I – Big ideas that all adults should know (Science for All Americans)

- Living organisms are complex, but they share the same principles of the conservation and transformation of matter with all other natural systems.
- Matter is transformed among living things and the physical environment, but the total amount of matter remains constant even though its form and location undergoes continual change.
- The elements that make up the molecules of living things are continually passed along the food web and eventually decomposers recycle them back to nutrients usable by plants.
- The total living biomass stays roughly constant, with a cyclic flow of materials from old to new life.

Section II – Instructional experiences that prepare middle school students to understand and use conservation of matter ideas (Benchmarks (BSL) and National Science Education Standards (NSES))

- Students must know about the properties of materials and their combinations, changes of state, the behavior of large collections made of pieces, the construction of items from parts so the unifying idea of atoms can begin by the end of 8th grade (BSL).
- Concrete perceptions must come before abstract explanations. Students need to become familiar with the physical and chemical properties of many different kinds of materials through firsthand experience before they can be expected to consider theories that explain them (BSL).
- An understanding of how things happen on the atomic level—making and breaking bonds—is more important than memorizing the official definitions (BSL).
- In grades 5-8, the focus on student understanding shifts from properties of objects and materials to the characteristic properties of substances from which the materials are made. Students observe, measure, and define elements and compounds operationally before they can comprehend the idea of atomic and molecular particles (NSES).

Section III – Middle school concepts and specific ideas (Benchmarks (BSL) and National Science Education Standards (NSES))

- No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same (BSL).
- The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how the same atoms are rearranged, then their total mass stays the same (BSL).

Continues on next page

Sample CTS Summary: (cont.)

- Substances react chemically with other substances in characteristic ways to form new substances. In chemical reactions, the total mass is conserved (NSES).

Section IV – Research on student learning (Benchmarks)

- Students cannot understand conservation of matter and weight if they do not understand what matter is, or accept weight as an intrinsic property of matter, or distinguish between weight and density.
- By 5th grade, many students can understand qualitatively that matter is conserved in transforming from solid to liquid. They also start to understand that matter is quantitatively conserved in transforming from solid to liquid and qualitatively in transforming from solid or liquid to gas—if the gas is visible.
- For chemical reactions, especially those that evolve or absorb gas, weight conservation is more difficult for students to grasp.

Section V – Storylines that unfold from K to grade 8 (Atlas of Science Literacy, Vol. 1)

The "case for conservation" develops from ideas about parts versus wholes, where things come from and where they go, and constancy in the midst of change.

- K-2: Most things are made of parts.
- 3-5: No matter how many parts of an object are assembled, the weight of the whole object made is always the same as the sum of its parts.
- 6-8: See Section III – Middle school concepts and specific ideas pertaining to the conservation of matter. No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same.
- 9-12: The map does not present any benchmarks beyond middle school. The conservation principle should be exercised, reinforced, and fine-tuned in high school. Conservation of matter has critical implications for a number of other topics – conservation of matter in living systems, recycling and nonrenewable resources, and issues of waste disposal.

Ideas about changes in the state of water also contribute to building the notion of conservation:

- K-2: Water left in an open container disappears, but water in a closed container does not.
- 3-5: When liquid water disappears, it turns into a gas in the air and can reappear as a liquid when cooled, or a solid if cooled blow the freezing point.
- 6-8 : No matter how substances within a closed system interact, the total mass of the system remains the same.

Section VI – Connecting to the state standards (Maine Learning Results (MLR))

See MLR Section D3, Grades 6-8: Matter and Energy – Students describe physical and chemical properties of matter, interactions and changes in matter; use the idea of atoms to explain the conservation of matter.

Project Profile: Composting Yard and Garden Waste

Lincoln Middle School in Portland, Maine has an active school garden, and eighth-grade physical science students realized they could help "green" their school by finding an environmentally responsible way to handle garden waste. With guidance from community composting experts, students researched and constructed a composting system and educated their school community about its importance.

While gathering data in the fall on how much plant waste had accumulated in the garden, students inquired about why there was no compost system. Recognizing that need had not yet been met, they wanted to address it.

Students invited the city's Solid Waste Management Division Coordinator to visit and explain the best methods for composting plant matter. They also visited a local waste management facility and researched online to learn more about the science of composting and the environmental effects of throwing plant matter in the trash.

Students wanted to pursue composting, but still needed to determine which method would be most effective. They interviewed composting practitioners and calculated the plant mass from different garden plots to determine the school's total annual plant mass. Their data showed that the system would need to handle up to 50 pounds annually, helping eliminate small-scale composters. Students voted to construct a 4-bin composting system, built from recycled wooden pallets.

New insights about plant cycles and composting were linked routinely to their curriculum units on the Conservation of Matter and Data Analysis. For both topics, the teacher completed a CTS and used rubrics to grade content-related assignments. In formative assessments, students received their score and written or verbal comments to help them improve, even if they already met the standard.

Students outlined needed tasks (such as siting, constructing and planning the establishment and maintenance of the system), and teamed up to complete them. Some students did further data analysis calculating how much compost starter material was needed, and what volume of leaves would be needed to achieve the ideal carbon-nitrogen ratio.

Students documented their progress on a chart in the classroom, and each class session began with a review of chart notes. Students succeeded in building and filling the compost bins before the first snowfall. To inform others of their progress, students made daily announcements and created a video for the school website (helping teach others how to construct their own composter). They celebrated their accomplishments with a pizza party where they watched the edited version of their video—for the first time—and saw a slideshow documenting the project.

At the end of the project, students described composting through a creative composition (e.g., a song, poem, or children's story) and reflected on their own learning. One student observed how this STEM project had shifted her attitude toward math: "I like science, but science that includes math… well, count me out. But, when a friend explained to me how to do it, it made sense and I started to love doing it. I hope we do something like this in science class again." High student engagement improved learning outcomes, observes their teacher Christel Driscoll: "Students gain so much from a real experience of scientific inquiry. Unlike a pre-determined lab experiment, students undertake research and develop a hypothesis."

Sample CTS Summary

Data Collection and Analysis

Section I – Big ideas that all adults should know (Science for All Americans)

- ✓ Science demands evidence. The validity of scientific claims is settled by observations and measurements taken from natural or laboratory settings. To make observations, scientists use senses and instruments, make collections, and actively probe the world.
- ✓ Summarizing data: Information is often in such great quantities that we are unable to make sense of it. A set of data can be represented by a few summary characteristics that may reveal or conceal important aspects of it. Statistics is a form of mathematics that develops useful ways for organizing and analyzing large amounts of data.
- ✓ To get an idea of what a set of data is like, we can plot and inspect to see where cases are piled up, where some are separate from others, where the highest and lowest are. Alternatively, the data set can be characterized in a summary fashion by describing where its middle is and how much variation there is around that middle.
- ✓ The most familiar statistic for summarizing data is the mean, or average, but care must be taken when interpreting it, as data can be skewed toward one extreme. The median (divides the lower half of the data from the upper half) or mode (most common single value) is sometimes more meaningful.

Section II – Instructional experiences that prepare middle school students to understand and use data (Benchmarks (BSL) and National Science Education Standards (NSES))

- ✓ At the middle school level, students can become more systematic and sophisticated in conducting their investigations, some of which may last for weeks or more. (BSL).
- ✓ With an appropriate curriculum and adequate instruction, middle school students can develop the skills and understandings of scientific inquiry, but teachers should note that students tend to center on evidence that confirms their current beliefs and concepts, and ignore evidence that does not agree with their current thinking. Teachers need to challenge and provide alternatives (NSES).
- ✓ Students should make distributions for many data sets, their own and published sets, which have already inspired some meaningful questions. The algorithm for the mean can be learned but not without recurrent questions about what it conveys—and what it does not (BSL).
- ✓ In studying data sets, questions like these should be raised: What appears most often in the data? Are there trends? Why are there outliers? How can we explain the data, and does our explanation allow a prediction of what further data would look like? What difficulties might arise when extending the explanation to similar problems? What additional data can we collect to try to verify the ideas developed from these data? How should we organize the data to present the clearest answer to our question? How should we organize the evidence to present the strongest explanation? (BSL and NSES).
- ✓ Out of the discussion about the range of ideas, the claims, and the data, the opportunity arises for learners to shape their experiences about the practice of science and the rules of scientific thinking and knowing (NSES).
- ✓ The distinction between ends and means should be kept in mind. The ultimate aim is not to turn all students into competent statisticians but to have them understand enough statistics to be able to respond intelligently to claims based on statistics; without the kind of intense effort called for here, that understanding will be elusive (BSL).

"When the students learned that polystyrene (aka Styrofoam™) was one of the worst biodegradable items in landfills. This raised a concern because they use polystyrene lunch trays every day in school. They began asking questions like "If they are so bad, why does our school use them? Data collection played a role in reinforcing the severity of the problem and increasing their motivation to come up with a solution."

— Monica Gaetano, North Albany Academy, Albany, New York

Section III – Middle school concepts and abilities (Benchmarks and National Science Education Standards)

- ✓ Scientific investigations usually involve the collection of relevant data, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected data (BSL).
- ✓ The mean, median, and mode tell different things about the middle of a data set (BSL).
- ✓ Comparing data from two groups should involve comparing both their middles and the spreads around them (BSL).
- ✓ Use appropriate tools and techniques to gather, analyze, and interpret data (NSES).

Section IV – Research on student learning (Benchmarks)

- ✓ Graphs: Students often interpret graphs as literal pictures rather than as symbolic representations. When constructing graphs, students have difficulties with interval scale and coordinates even after traditional instruction in algebra. When interpreting graphs, students do not understand the effect that a scale change would have on the appearance of the graph. Students read graphs point-by-point and ignore their global features.
- ✓ Summarizing data: The concept of the mean is quite difficult for students of all ages to understand even after several years of formal instruction. Some middle-school students cannot use the mean to compare two different-sized sets of data; high-school students may believe the mean is the usual or typical value.
- ✓ Interpretation of data: Students of all ages show a tendency to uncritically infer cause from correlation. Some students think even a single co-occurrence of antecedent and outcome is sufficient to infer causality.

Section V – Storylines that unfold from K to grade 8 (Atlas of Science Literacy, Vol. 1)

- ✓ The "data story" develops from ideas about averages and spreads, related changes, probability, prediction, and sampling. Ideas and skills focus on finding and interpreting patterns in data. Summarizing data grows from:
- ✓ K-2: Numbers can be used to count things, place them in order, or name them.
- ✓ 3-5: A summary of data includes where the middle is, and how much spread is around it.
- ✓ 6-8: The mean, median, and mode tell different things about the middle of a data set.
- ✓ 9-12: The middle of a data distribution may be misleading (when the data are not distributed symmetrically, or when there are extreme high or low values, or when the distribution is not reasonably smooth).

Section VI – Connecting to the state standards (Massachusetts Science and Technology/Engineering Curriculum Framework)

- ✓ See MA Framework: Skills of Inquiry, Experimentation, and Design, Grades 6-8:
- ✓ Select appropriate tools and technology and make quantitative observations.
- ✓ Present and explain data and findings.
- ✓ Draw conclusions based on data or evidence and make inferences based on patterns or trends in the data.
- ✓ Communicate procedures and results using appropriate science terminology.

Note: Both of the preceding CTS summary examples incorporate Maine state standards since the participating teachers lived and worked in Maine. To find the appropriate standards for your state, contact administrators in your local school district or the STEM specialist at your state Department of Education.

Project Profile: Reducing Roadside Trash

Participating in an annual roadside cleanup organized by Friends of Acadia, eighth-grade science students at Pemetic School in Southwest Harbor, Maine found significant numbers of "take-out" containers and coffee cups. They created a service-learning project to help address this problem and reinforce their studies on the flow of matter and energy, cycles, conservation of matter and human impact on the environment.

Most of the school's students are well acquainted with "green" practices as environmental practices and ways of understanding are already integrated into the school culture. To extend this knowledge and get inspired to do more service-learning, the class read Going Blue: A Teen Guide to Saving Our Oceans, Lakes, Rivers, & Wetlands).

To determine which types of trash were most prevalent in their community on Mount Desert Island, students divided trash into four categories: polystyrene (i.e., Styrofoam™); plastic; trash; and returnable cans/bottles. After a two-hour roadside cleanup, they analyzed the data and discussed how trash on an island can readily pollute the ocean (tying this problem to their recent curricular studies of the water cycle, the Pacific trash gyres, and food webs). Students decided to focus on two items—coffee cups and take-out containers—where they felt they might have an impact. Since their school still served some desserts in polystyrene containers, students decided to incorporate that problem into their project.

Students designed a detailed survey that they administered to 13 area businesses and restaurants—assessing what takeout containers they used, what recycling practices they had, and whether they were open to changing products. After analyzing their survey data, students identified ways they could help businesses improve their recycling practices (e.g., informing them of local recycling policies and procedures, and helping more of them understand how prevalent roadside trash is). The end of the school year prevented further implementation of these "solutions," but the next eighth grade science class may take over the project.

Students met with the school chef to discuss other packaging options for the cafeteria's frozen yogurts. When they learned alternatives might be more expensive, they surveyed students and found 100 percent would rather have frozen desserts in more environmentally sound packaging, even if they were served less often. The class shared these results with the chef, and she promised to look into alternatives.

Throughout the project, students engaged in reflection and collaboration as they worked in teams and met with others frequently to discuss successes and challenges. Students role-played in preparation for interviews and surveys. "Having data to share helped validate what the students were doing (especially when they presented their concerns to others)," reflects their teacher Bonnie Burne. "Service-learning provides a rich opportunity for students to really make a difference and to learn real-life skills that they will use as adults."

Plan and Implement Your Project

In addition to completing the CTS process, you'll want to review the KIDS Consortium guide KIDS as Planners (KAP), which describes how to structure your project so it meets the highest standards for service-learning. Teacher-tested tools like the "Project Overview Circle" (pp. 26 and 97, KAP), "Project Learning Web" (pp. 27 and 98, KAP) and "Planning Backwards" (pp. 32-33 and 99, KAP) can help ensure that your project incorporates the core KIDS principles and adequate means of assessment. Many teachers use rubrics (pp. 29-31, KAP) based on their CTS summary to tie student assessments to core curriculum concepts.

"To determine student depth of understanding, I created rubrics using CTS materials. The rubrics are standards-based and include the vocabulary and concepts found in the benchmarks material of CTS."

F ranklin Sames, Lincoln Middle School, Portland, Maine

Data and Analysis/Evidence and Explanatioin Rubric (example rubric)

4.0	• Students identify additional data they can collect to try to verify the ideas developed from their date.
3.5	Demonstrates long term knowledge and can explain understanding.
3.0	• Students can explain the date, and apply it to predict what further data would look like. • Students can recognize claims lacking scientific support and/or scientific bias within data. • Students use logical reasoning and creativity in devising hypotheses and explanations to make sense of collected data.
2.5	In addition to 2.0, Partial knowledge of higher level problems.
2.0	• The mean, median, and mode tell different things about the middle of a data set. • Students identify data trends and outliers. • Students create their own labeled tables, graphs and diagrams of data.
1.5	Partial knowledge of 2.0.
1.0	With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes
0.5	With significant teacher assistance, a partial understanding of 2.0.
0.0	Even with help, no undersanding or skill demonstrated.

Teachers often begin their STEM projects with activities to familiarize their students with service-learning (such as the KIDS Consortium "What Is It" game, http://www.kidsconsortium.org/games.php). From there, the entry point into the project depends on how much curricular flexibility and time you have. You might invite students to consider multiple topics; suggest a single topic (within which they can choose a specific problem); or have students select a specific problem (the best option if time is limited). The "guided discovery" process (p. 22, KAP), during which you and your students explore potential problems/needs, will help clarify the focus and parameters of your project.

Choosing a problem to address can be a valuable exercise in collaborative decision-making. Some teachers employ the "N-3 Prioritizing" approach (pg. 53, KAP) to help students move from a wealth of brainstormed options to a focused problem statement. The "Know-Want-Learn (KWL)" activity (pp. 54-55 and 106, KAP) can be used to further "unpack" the problem and determine what data are needed before deciding on a solution. Students record what they know about the problem already, what they want or need to know (e.g., about its history, causes and effects) and how they will learn that. The finished summary can help guide students as they move from preliminary research to selecting and implementing a solution.

> "The students and I documented progress collaboratively. I copied the KIDS "Action Plan with Timeline" chart [page 115, KAP] onto the SMART Board [an interactive whiteboard] for each class. The 'objectives' came from the 'What do we want to learn?' in the KWL chart. The 'tasks and activities' section came partially from the 'How will we learn?' section in the KWL chart. I presented each chart and, as a class, we discussed what other tasks and activities were needed to fulfill the objective. This chart was left up during each class so that students could add notes about what they were working on and what progress they had made. At the beginning of the next class, we spent 5-10 minutes reviewing the notes and offering feedback/ suggestions."
>
> *— Christel Driscoll, Lincoln Middle School, Portland, Maine*

In guiding your students through steps 3-6 of the KIDS Framework (during which students investigate problems, research solutions, decide on a project, and plan it out), remind them to collect and analyze sufficient data to inform their decision-making on both problems and solutions. Students (and teachers!) may be tempted to short-circuit this preliminary process of research and reflection, moving right into adopting a single "obvious" solution. But the National Research Council's Framework for K–12 Science Education clearly recommends that students have opportunities to gather, analyze, display and discuss authentic data repeatedly over multiple years, and it supports their integration of knowledge and abilities in meaningful learning situations. Refer back to the preliminary data you've gathered and use the "Comparing Solutions" and "Decision-making Matrix" tools (pp. 63 and 65, KAP) to ensure that you have fully vetted possible solutions.

> "We got caught up many times in students' ideas and wanting to accommodate everyone at the same time. Even with two teachers, it was too much to do, and not a good choice on our part. Students were excited about certain ideas and ran with them, which was great, but there needs to be more focus. Having deadlines and keeping focused would have been a better way to go."
>
> *— Lisa Pratt, Roosevelt Middle School, New Bedford, Massachusetts*

While the YACS project profiles (online at kidsconsortium.org) often highlight particular stages or elements of the KIDS Framework, the following sample "storyboards" illustrate how each step of the Framework (including the "cloud" elements) took shape in two middle-school STEM projects.

Sample Project — Unpacking a KIDS Project

More Efficient Hand Drying

School: Lincoln Middle School, Portland, Maine

Teacher: Rob Lindsay

Define Service Learning

- Following a curriculum unit on climate change, sixth- and seventh-grade students wanted to undertake a project that would reduce their school's carbon footprint.
- The teacher shared information about previous service-learning projects at the school that had reduced energy use, such as energy audits and installation of solar panels.
- Students played the KIDS Consortium What Is It? Game, an interactive activity that helps introduce core concepts of service learning.
- Students chose three words they associated with service learning, and the teacher created a "Wordle" that prominently depicts the most frequently chosen words.

Discover Needs/Problems

- After learning sobering facts about climate change, students wanted to make a positive contribution by reducing their school's carbon footprint. This "single problem entry point" was well-suited to a month-long service-learning project.
- By examining features of LEED-certified green buildings, students got ideas for ways to improve energy efficiency in their school.
- Students were most interested in exploring the potential for replacing bathroom paper towels with high-efficiency hand dryers.

Investigate Problems

- Students consulted with an AP science class at Casco Bay High School that had written a successful grant proposal for more efficient hand dryers.
- The Maine Energy Education Program sent two interns by to teach students how to measure kilowatt hours and read appliance plates.
- Students gathered data on paper towels and dryers, surveying students and interviewing custodians to learn more about paper towel use.

Research Solutions

- Breaking into committees (i.e., ones for surveys, presentations, coordinating, timeline, math liaison, hand dryer research, and paper towel research), students began to analyze life cycle costs and carbon emissions for towels and dryers.
- They watched videos and read reports, trying to assess energy use and carbon dioxide emissions at each phase of the product's life cycle.
- Students used math skills to compare the economic costs of towels versus dryers (comparing the costs and carbon output of various hand dryers, estimating how long hand dryers would last, and the volume and cost of paper towels consumed over that period).

Decide on a Project

- Students reviewed their findings and unanimously decided to pursue purchase of the more expensive dryer because it had significantly less carbon output (before the teacher could even use the intended decision-making matrix!)
- Students projected that operating high-efficiency dryers would save the school a modest amount of money over time and would reduce its carbon dioxide emissions by 122.5 kilograms/year.

Plan the Project

- The teacher relied extensively on the KIDS "Student Planning Sheet" [p.116, KAP], which proved to be especially helpful coordinating the work of four classes.

Implement the Plan

- One student committee developed a PowerPoint presentation to share the team's findings with the school principal and district facilities manager.
- The administrators approved the purchase and students discussed their funding plan for the purchase
- The facilities manager agreed to install the dryers following their purchase.
- Students discussed how they would inform and engage the school community so they would use the new hand dryers.
- Funds from a KIDS Consortium Green Schools grant helped cover some of the projected costs, but students needed more money to purchase a second dryer. Two students wrote a successful grant application for the additional funds.
- To educate the school community about the new dryers, the students made posters and a display with flyers. They created a movie and PowerPoint presentation, and wrote stories for the school newsletter and local newspaper.

Evaluate Impacts

- When the new hand dryers are installed, students plan to collect data from custodians and students to determine how much paper towel use has declined and whether the hand dryers are working well and meeting users' needs.

Reflection

- At the end of each project session, students noted what they had learned, what questions had arisen, and what next steps they planned.
- When they completed the project, students repeated the initial exercise listing three words they associated with service-learning. The resulting class Wordle showed that they had gained a deeper understanding of service-learning.
- Students who wanted to attend the KIDS Consortium School Summit wrote additional reflections about what they hoped to share with other students.

Collaborative Environment

- Students did team-building games and activities at the project's outset like a tarp flip and building marshmallow towers.
- The classes developed group norms to guide their teamwork. The teacher carefully observed group interactions during initial weeks and gave feedback, and students evaluated their own adherence to the norms following the first week.
- Student committees reported back to the whole class once or twice each week. Because four classes worked on this project simultaneously, members of the presentation and coordinating committees met routinely at lunch to review progress and share information.
- The success of this project inspired a group of students to continue meeting at lunch time throughout the school year to explore other service-learning opportunities and lay plans for the following year.

Public Relations

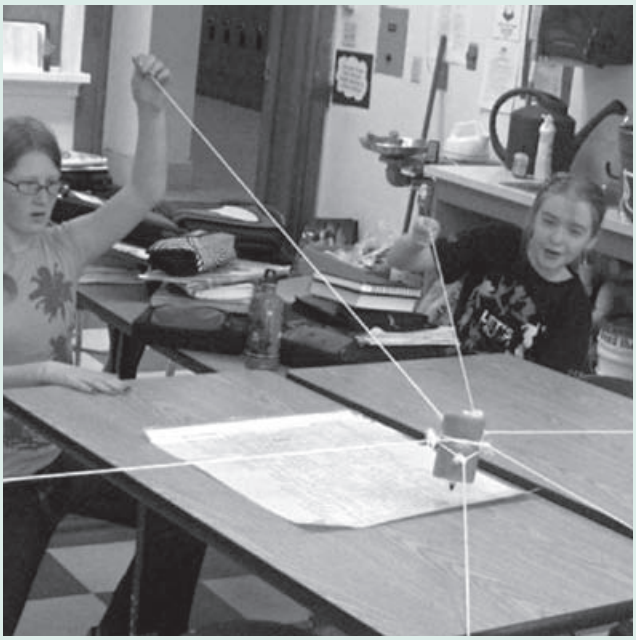
- Students shared their research and plans with members of the school community and the larger community through an article in the school newsletter, and letters to the editor in the local paper.
- During a Parent Night and Step-up Day at the school, students had a display with flyers, posters, a PowerPoint, a movie, and a diorama that they had made.
- The students created a comic book and puppet show to help younger students at area elementary schools and preschools understand their project.

Celebration

- When students received notice that the principal had approved purchase of the new dryers, they held a party. Smaller, more informal celebrations were held upon completion of major tasks.

Curriculum, Instruction and Assessment

- Students completed an individual assessment and a rubric the teacher developed to gauge how the products they created during the project helped fulfill curricular requirements.
- The project fulfilled many STEM learning goals, building skills and traits of scientific inquiry; using math to gather, organize and present data; and increasing student understanding of ecosystems, energy transformations and human impacts.



Sample Project — Unpacking a KIDS Project

Tapping into the Bottled Water Dilemma

School: Crossett Brook Middle School, Duxbury, Vermont

Teacher: Sarah Popowicz

Define Service Learning

- Students in four seventh- and eighth-grade integrative science classes were introduced to service-learning through a PowerPoint presentation that helped them differentiate service-learning from community service and community-based learning.
- Students played the KIDS Consortium What Is It? game, an interactive activity that reinforces core concepts of service learning.

Discover Needs/Problems

- During a lab investigation, science students read an article that described the environmental costs of plastic water bottles. They began to consider their own contribution to this problem, and decided to investigate the use of plastic water bottles at their school (a "specific problem" entry point entirely driven by student interest). Fortunately, the problem they identified fit well with the class curriculum on human resource consumption and its impact on natural systems.
- Students entered the discovery process with many questions about bottled water, and began reassessing marketing statements they had previously accepted as facts. Is bottled water safer than tap? Does all tap water taste bad? Do plastic water bottles really get recycled?

Investigate Problems

- Students began by exploring the manufacturing, consumption and disposal of plastic water bottles. Through research online and consultation with staff at local recycling centers, they were able to answer many of their initial questions. Their findings augmented their study of resource consumption and human impacts (e.g., learning of the Pacific trash gyres and greenhouse gas emissions from plastics manufacturing) and energy cycles (e.g., finding that only 20 percent of bottles are recycled).
- Collecting and analyzing pre-project data gave students a better sense of the problem and extensive practice with data analysis. They conducted a school-wide survey to determine their bottle use and found interesting disparities between what respondents said they did (recycle the bottles) and what actually happened (students collected 143 bottles during a one-week period that had been discarded in the trash). They categorized the types of bottles collected, and found a third of them were water bottles.
- The class polled students about taste preferences and found that slightly over half thought bottled water tasted better. Yet a blind taste test involving 154 students revealed that 71 percent of students did not choose bottled water as their preference.

Research Solutions

- Students needed to find a viable, cost-effective means for students to get adequate water without bringing or purchasing disposable bottles at school. Transporting water in stainless steel canteens seemed like a good option, but students needed to determine how students would acquire these and how they could fill them at school.
- Students recognized that they would need to educate the school community about the environmental problems associated with plastic bottles in order to change engrained habits.

Decide on a Project

- Each of the four science classes selected a different component of the project as their focus: gathering data on trash; conducting a prior knowledge survey and researching stainless steel water bottles; conducting a schoolwide taste test; and researching issues involving the state's bottle bill. Students decided that they would conduct a "Take Back the Tap" educational campaign within their school; purchase stainless steel water bottles (with grant money the school had received); and have water fountains retrofitted to allow for bottle-filling.

Plan the Project

- With four different science classes all following the KIDS service-learning framework, a dedicated project board helped facilitate collaborative planning—providing daily progress updates as each class moved from researching the problem to planning, implementing and evaluating solutions. "This planning model allowed students to feel connected to all aspects of the project," reflects their teacher Sarah Popowicz.
- Students were able to work on different facets of the project when their own work was at a standstill. Groups helped each other out, offering extra hands and problem-solving when needed. "This made the entire project a collaborative team effort," Popowicz notes.

Implement the Plan

- Students created a prior knowledge survey, using Survey Monkey, to determine why members of the school community used plastic water bottles. Surveys were taken over two days using laptops in the cafeteria during lunch.
- Students conducted a blind taste test comparing tap water to bottled water during lunch periods to dispel the myth that all tap water tastes bad.
- To raise awareness about the financial and ecological costs of bottled water, students created informational posters and a PowerPoint presentation.
- Using a Green Schools grant from KIDS Consortium, students purchased 250 stainless steel canteens (one for each member of the school community), with a logo custom designed by a classmate.
- Students worked with school administrators and custodians to have water fountains retrofitted with bottle spouts, making bottle-filling easier.
- Students built a 6-foot-high "bottle mountain" (with the bottles they had collected from the school trash) and placed it in the school's entry so that other students and staff could visualize how much waste was generated in a one-week period.
- Students organized a school-wide "Take Back the Tap" awareness day with a PowerPoint presentation on their research; an informational scavenger hunt; and distribution of stainless steel water bottles.

Evaluate Impacts

- Students completed a post-project survey to determine how effective their "Take Back the Tap" campaign had been. They did checks of recycling and trash bins and counted the number of reusable containers collected—analyzing their data to determine how extensively habits had been changed. By comparing these findings to their pre-project survey data, they could quantify the extent of change.
- Their follow-up survey showed that 85 percent of students became more aware of water bottle concerns and 70 percent no longer felt that bottled water tasted better or was healthier than tap water. Purchase of bottled water at school vending machines declined, indicating that more students were now using their stainless steel bottles.

Reflection

- Students sought to encourage reflection in others through creative educational tactics—like their plastic water bottle "mountain" sculpture—displaying flags citing the environmental costs and topped with a sign reading "Is it worth the price we pay?"
- Reflection on the project inspired some students to create a comic book for younger children with characters such as Recycle Girl and Master Trash.

  "I can't believe the impact this project made on my students and myself," Sarah Popowicz observes. "I have a group of students who now not only understand the impacts of consumption, but actively participate and spread the word about easy solutions. What more could you ask for?"

Collaborative Environment

- To create a collaborative environment, students participated in ice breakers like "Face Off"and "Zip, Zap, Zooey." They also participated in "scientist circle" discussions. The open communication and support established early on continued throughout the project.

Public Relations

- The "Take Back the Tap" campaign students created raised awareness in their school community through posters, a PowerPoint presentation, informational activities, a school wide scavenger hunt and a 6-foot "bottle mountain."
- Local media coverage helped carry their message to the broader community.
- Students presented the project to several other schools and to a meeting involving all the district's principals, helping generate interest in adopting similar projects.

Celebration

- Students were enthusiastic throughout the project and had lots of opportunities for hands-on engagement (e.g., building the bottle mountain, conducting the taste tests, distributing water bottles). Students held a celebratory breakfast, and the school honored their work "greening" the school. But the best reward was internal, as one student noted at the project's conclusion: "I never would have thought that we could have made such a big difference in our school, but we did. It feels good to know we did something good for our planet."
- When they completed the project, students were so enthused about waste reduction that they wanted to take on additional efforts. Some students helped sew reusable "sandwich" bags that they could use in their lunch boxes in place of plastic bags.
- After the project was completed, students presented to the Superintendent, District Curriculum Coordinator, and all the Principals within the district, getting feedback on their project and celebrating what they had achieved.

Curriculum, Instruction and Assessment

- Students were assessed using rubrics (to evaluate class participation and collaborative group work) and written/artistic reflection on concepts learned and community impact.
- The project fulfilled many State standards, such as having students demonstrate their understanding of scientific questioning and experimental design; show their ability to represent and analyze data; and understand resource consumption and how it affects natural systems.

Students raised awareness about the problem of water bottle disposal by constructing a mountain of the bottles their school generated in a single week. Part of their solution was to purchase and distribute stainless water bottles for all students and staff.

Valuable Service-Learning Tools

As the two sample storyboards illustrate, STEM/service-learning projects succeed best when students work closely and effectively as team members to research a problem and implement solutions. Collaboration and teamwork require skills; lay the groundwork for this skill-building early in your project through ice-breaking and team-building activities and by collectively setting group norms. KIDS as Planners has a listing of suggested Ice Breakers (pp. 101-102) and a popular GOILS (Groups of Increasingly Larger Sizes) activity (p. 38) that teachers frequently use to help their classes craft norms to guide their group interactions (e.g., listen to others, participate fully).

> "At the very beginning of the school year, I used the GOILS method as a way for students to establish group norms. The group norms were posted on the classroom wall where students could refer to it. Throughout the project students completed quick checklists to reflect on their individual behavior during group work, and on the function of the group as a whole. I also facilitated ice breaker and team building activities during the school year... Working with the CTS model and service-learning helped me recognize the importance of letting students make mistakes and have time to problem-solve as a team."
>
> *— Cindy Cote, Presque Isle Middle School, Presque Isle, Maine*

Building in opportunities for ongoing reflection will foster collaboration among teams and help them stay focused. Reflection opportunities can center on the project (what's working, what's not and why); the process (who will be doing what tasks, how is the class doing on group norms); or the learning (what insights are there to date and what questions remain). Teachers in the YACS initiative relied on a range of reflection tools—from class discussions and short writing assignments (such as "exit tickets" at the end of a class) to longer essays. Many "Green School" teachers had 3-4 classes working simultaneously on a project, requiring good communication and careful coordination among groups. The Student Planning Sheet (page 116, KAP) can be helpful when working with many teams focused on different facets of a shared project.

> "Collaboration is a particular strength of the KIDS method. In service-learning, students are all working together to solve common problems. We seldom do that in public education, and it's a powerful thing."
>
> *— Rob Liebow, Superintendent, Mount Desert Island Regional School System, Maine*

> "After their work was done, I led the students through three reflective activities. The first involved their writing Haikus on a water-quality theme. We also did a Scrabble Scramble in which students created words meeting certain criteria (the most creative, the most scientific, etc.) that focused on the unit. The third involved reflecting on our accomplishments alongside the brook after the final celebratory release of the brook trout."
>
> *— Martin Mlyniec,Lisbon Central School, Lisbon, Connecticut*

Measure Success

Plan your means of evaluating your project's impact early on so you can gather the quantitative and qualitative data you'll need for pre-project and post-project comparative assessments. You'll want to measure your project's impact at multiple levels, including:

Student Learning

- student understanding of curricular topics (see next section);
- other student impacts (e.g., level of motivation and interest; communication and collaboration skills; and ability to think critically and across disciplines)

School/Community Impacts

- changes in your school's culture and practices and
- broader community impacts.

Measures of your project's success can be used to both prove and improve the effectiveness of your school's or district's STEM/service-learning programs.

Assess Student Learning

Both teachers and students evaluate student learning during the project and at its completion. Through reflection activities, students can assess what they have learned, what they contributed, and what they will carry with them as they move forward.

Teachers engaged in STEM/service-learning use many of the following means of assessment to determine the project's impact on student learning:

- Reports that include research methodology, findings and recommendations
- Oral presentations or demonstrations to peers, school board or local government
- Public performances (e.g., a play, forum, public service announcement, or television interview)
- Field notes and observations
- Letters and press releases
- Learning logs or book response journals in which students share ideas and questions prompted by lessons and reading assignments
- Portfolios of student products (including writing, audio or video productions, and maps)
- Products of community value (e.g., a sign, mural, museum exhibit or brochure)
- One-on-one conferences
- Self and peer assessments
- Communications products (e.g., a poster, logo, multimedia presentation or web page)
- Documents that conform to professional standards (e.g., a scale model, master plan or grant proposal)
- Procedures that meet technical standards (e.g., water-quality monitoring or cataloging artifacts)
- Standards-based lesson plans and tests

"In a STEM/service-learning project conducted last fall in one of my grantee's schools, middle-school students used data collection and analysis to study asthma in urban neighborhoods. When preparing the next spring for the Massachusetts Comprehensive Assessment System test, these students—with no review—aced the sections on data collection and analysis (averaging scores of 9 or 10). With other topics, some even taught the previous week, they struggled (scoring 5 or 6 out of 10). Their mastery of data analysis ties directly back to their STEM project: they learned that material in a relevant, meaningful context so it stuck with them."

— *Kristen McKinnon, Service-Learning Specialist, Massachusetts Department of Elementary and Secondary Education*

Assess School and Community Impacts

Community impact is one of the more difficult areas to assess, and it can readily be neglected if those planning and implementing a project do not pay close attention to evaluating it. Teachers in the YACS initiative used a range of quantitative and qualitative means to measure their project's impact on their schools and communities.

- **Quantitative measures:** volume of waste recycled or composted; percentage change in electricity/resource use; number of "indicator species" in local waterways; percentage reductions in trash generated; cost savings (in reduced purchase of disposables); energy savings; change in awareness or practices documented through pre- and post-project surveys of school community; and increased numbers of participants or beneficiaries.
- **Qualitative measures:** observations by school administrators and community partners; student reflections; change in habits/practices at the school (e.g., more students carrying reusable water bottles or fewer lights left on in unoccupied rooms); comparisons among pre- and post-projects interviews and observations; and teacher reflections.

For both quantitative and qualitative measures, consider developing survey tools, interview questions, and other formal means of gathering data—rather than counting on anecdotal observations or unsolicited feedback from others. Invite those affected by the project to address questions such as:

- How did this project benefit the community?
- Do those affected by this project value its outcome? How and why (or why not)?
- What could have been done differently?
- Did this project meet your standard for quality work? Why or why not?

For a more detailed survey form to use with community partners, see pp.118-199 in KAP.

"We had a lot of initial quantitative and qualitative data to compare to our post data. Based on survey results, student awareness of the bottled water issue increased by over 85 percent, and more than 70 percent changed their opinion that bottled water tastes better and is healthier than tap."

— *Sarah Popowicz, Crossett Brook Middle School, Duxbury, Vermont*

"Each one of [the Green Project students] were well-prepared and spoke coherently and enthusiastically about the project. There wasn't a question they didn't tackle thoughtfully and seriously. I was impressed with their description of the birth of the project, the questions they had, and the research they'd done. Their resounding YES when I asked if they like learning this way was evidence that service-learning profoundly impacts students in a way that a textbook can't. This is meaningful, authentic learning, evident in how the students care about what they're doing. This method of learning will undoubtedly impact these kids well into the future. Powerful stuff."

— *Anne Blanchard, Principal, Presque Isle Middle School, Presque Isle, Maine*

"What you and the kids are doing will go a long way. The kids are getting involved, which will carry into their home life into their older years."

— *Craig Pyy, Solid Waste Coordinator, City of Portland (Maine)*

Youth as Citizen Scientists Initiative Outcomes

In the Youth as Citizen Scientists (YACS) initiative, teacher and student evaluations and reflections were augmented by an external evaluation (designed by Brandeis University's Center for Youth and Communities in collaboration with KIDS Consortium and Maine Mathematics and Science Alliance). This section summarizes the Center's findings, drawn from surveys of community partners, teachers and students as well as interviews with school administrators. Since the focus of the YACS initiative was "Greening Schools," some of the community partners were within the school (e.g., facilities managers and food service directors). Of eleven community partners involved in YACS projects that KIDS surveyed, 90 percent agreed or strongly agreed that the YACS service projects were designed to address an important local need or problem and 80 percent reported that they succeeded (although a few ran short on time and are continuing in the next school year).

Survey data from students involved in the YACS projects indicate that the incorporation of service-learning into STEM instruction led to important gains in STEM-related outcomes. The students were more likely to report that they understand how a scientific method can be used to solve real world problems and that they know how to use data to understand the causes and effects of an environmental problem. Students also showed gains in reporting that they talk about local environmental issues with friends or parents.

Teachers involved in the YACS initiative reported, at the end of the school year, that the projects enhanced STEM content, skills and motivation of students. Ninety percent of participating teachers reported gains in their students':

- sense of engagement in learning;
- ability to do authentic science work;
- ability to apply science concepts to solve;
- problem-solving strategies (e.g., using steps to think through a problem);
- understanding of community problems or needs;
- ability to collect, analyze and interpret data;
- ability to clearly communicate data to others;
- concern for and/or understanding of the environment; and
- ability to meet high standards of learning.

The administrators interviewed also felt that these projects represented improved approaches to teaching STEM skills and content, as the following comments indicate:

"The learning is relevant, student driven, engaging and hands-on. Students would request to present to me. To watch them present, well, I have been in education for 38 years and this enthusiasm is beyond what you normally see in a given unit of learning. Relevance.That is the key word. If they find it relevant, they are more apt to engage and invest. These kids were curious and curiosity was permissible. It was important to ask questions and seek, rather than listening to lectures and take notes."

"I see kids that are active and engaged in a way that I don't see in a lecture class...as far as kid impact, I see only positives."

Students involved in YACS projects showed statistically significant increases in civic skills and knowledge such as knowing how to influence the decisions that are made in my school or community; feeling confident sharing opinions in front of a group; and working with others to solve environmental problems. In addition, YACS students reported feeling more like important parts of their community.

Students also showed highly significant positive gains in the following civic skills, many of which are considered critical to 21st-century learning (www.p21.org) when assessed at the end of their YACS projects.

Research

- Identify environmental needs or problems that are important to your school or community.
- Find information on environmental issues related to your school or community.
- Use different sources to gather information on a school or community problem (e.g., newspapers, the Internet, people in government agencies or community organizations).
- Make phone calls or conduct interviews to gather information on a school or community problem.

Critical Thinking and Problem-Solving

- Decide what is important to think about in choosing a school or community project.
- Look at different ways to address a school or community problem until you find a solution
- Compare the pros and cons of different solutions to a school or community problem.
- Set up a timeline and action steps for a school or community project.
- Manage your time so you can get all the steps in a project done.
- Change what you are doing on a project to make it work better.
- Evaluate your project to figure out whether or not the project made a difference.

Collaboration

- Identify people who need to be involved in a school or community project.
- Identify the steps that are important when a group needs to make a decision.
- Work on a team with other students to make decisions about a school or community problem or project.
- Identify and use the skills needed to make a team work well together.

Communication

- Make a presentation using charts, graphs, computers, video, or other types of presentation materials.
- Communicate to other people about something you think is important.

> "I thought the program was a great success. The students worked hard to establish a recycling program in our school and to make it work. They had a lot of great ideas, but we either did not have the time or the resources to start their ideas this year. I am hoping to keep the recycling program growing by establishing an afterschool Green Team that will implement many green projects in the school."
>
> *— Shannon VanDyke, Hackett Middle School, Albany, New York*

A consistent finding in service-learning research is that the quality of the program experience for participating students (as defined by the national K-12 Service-Learning Standards for Quality Practice) largely determines the degree to which service-learning has a positive impact. The KIDS principles and Framework represent important guides for effective service-learning. In studies of KIDS and other service-learning programs, students showed greater gains on measures of civic attitudes (relative to peers whose projects did not share these qualities) when they had a decision-making role in the project (Youth Voice); felt they had real responsibilities for an important project (Meaningful Service); worked with a community partner (Partnership); had opportunities to talk and write about the project and present or discuss results with community members (Reflection); and had a project related to their studies (Links to Curriculum).

These findings confirm that quality service-learning experiences require an extended commitment of time on the part of teachers and students. The KIDS Framework, refined over two decades, reflects this systematic and thorough approach. Service-learning projects that rely on the Framework and achieve the required intensity and duration lead to demonstrably better outcomes.

Take STEM and Service-Learning to the Next Level

In addition to assessing student learning and community impacts, it's important to reflect on your own teaching experience and what lessons you learned that would apply to future projects. Teachers involved in the YACS initiative completed a self-assessment based on a chart developed by the Institute for Global Education and Service-Learning (see Appendix C) to gauge the degree to which their project met national K-12 Service-Learning Standards for Quality Practice. They also responded to the following questions designed to prompt reflection on their service-learning project:

- How did implementing your STEM/service-learning affect you personally?
- How has this project contributed to your professional growth?
- How has this project contributed to student understanding, engagement, or motivation?
- How did it shape their ideas of what scientists do?
- What do you do differently as a result?
- What plans do you have for sharing with others in your school or district and beyond?

As you anticipate next steps, you may be wondering how to develop or extend your practice of STEM/service-learning. What do you need in the way of networking, professional development, and mentoring to keep learning and growing? If you're fairly new to service-learning, you'll want specialized training in both service-learning and CTS, and you'll want some coaching as you work to integrate these into the classroom.

In the first year of the YACS initiative, teachers who were **new to service-learning** received on-site, professional development from KIDS Consortium staff on what service-learning is and how to implement the KIDS Framework. At the end of that year, they attended a 3-day summer institute that provided guidance on CTS and incorporated models of STEM/service-learning projects from the "design sites." YACS participants who were more **experienced service-learning practioners,** learned about CTS during the first year (carefully documenting their projects), and then helped design professional development for teachers new to service-learning.

During the second year, all YACS projects focused on data-gathering and teachers completed both a CTS on Data Collection and Analysis and a CTS related to their study topic. On-site visits and coaching from KIDS Consortium and MMSA staff were also provided as teachers and students implemented their projects.

"The professional development offered by KIDS Consortium and Maine Mathematics and Science Alliance has been invaluable. Each time I attended their presentations, I picked up a new technique or idea to improve my facilitation of service-learning with students. Meeting and working with them has been a way to reflect upon my adventure into service-learning. The enthusiasm of everyone involved in service-learning is contagious!"

— Elaine Hendrickson, Presque Isle Middle School, Presque Isle, Maine

During the second year, participants were also asked to look for ways to sustain high-quality STEM/service-learning projects beyond the grant, and to envision how their schools might be in five years with that STEM/service-learning in place. They also considered what action steps they could take to make that vision possible (see the following example).

STEM/service-learning vision in an urban middle school

- In five years, all students at the school will have multiple experiences with service-learning, completing at least one project per year. Students will feel and be empowered, knowing how to use service to learn academically, pursue their own interests, and make positive changes in the school and the community (including helping train new students).
- Staff will be highly skilled at using service-learning to help students meet standards, and identify and investigate problems. All staff members, from cafeteria workers to administration, will enthusiastically embrace service learning. Service-learning projects will be shared across disciplines, and staff will continue training on service learning (including the Student Service-Learning Summit).
- The community will see the school as a vibrant place to connect with students and their learning, and as an equal partner. The school will hold regular service-learning fairs to learn of problems that community partners need help with or can help to address. Students will share projects and solutions with each other and the community at these fairs.

Action Steps:

- To ensure that every student has at least one service-learning experience each year, the school is putting the following supports in place:
- Provide CTS professional development for all science teachers
- Purchase CTS guides for all grades
- Provide professional development on service-learning for all its teachers and purchase each a copy of the KIDS as Planners guide
- Provide on-going coaching/mentoring (provided in part by KIDS Consortium via a consulting contract) for all teaching teams as they plan and implement service-learning
- Dedicate a part-time staff position to supporting the service-learning activities and needs of teachers as they plan and implement their projects.
- Involve a group of students (during the school day) in planning and helping host the Student Summit on Service-Learning.

"Because I am becoming more familiar with the KIDS model for service-learning, I find myself always thinking of ideas for service-learning projects. I know many teachers are intimidated by this idea because they are not familiar with the process so sharing my projects will hopefully inspire them to want to incorporate service-learning in their curriculum."

- Christel Driscoll, Lincoln Middle School, Portland, Maine

While the participating YACS sites have different circumstances and constraints, they are all working to systematically integrate STEM/service-learning into their professional development and curriculum work (on either a school-wide or district-wide basis). Many of the more experienced YACS sites seek to offer their students multiple opportunities to participate in STEM/service-learning (once a year or once in each 3-year grade span).

To succeed at embedding STEM/service-learning into the culture and practices of their schools, teachers need to: feel supported; have some scheduling flexibility; participate in related professional development opportunities; and have opportunities for collaboration across disciplines. (For more ideas on how to build a network of allies and generate broader support for service-learning, see pages 86-91 in the KAP guide.)

> "Trying to have a project that is more student-driven and led was challenging for me as a teacher. In particular, it was difficult for me to estimate and plan the time needed for the different steps of the process since I was not 'in charge' in the usual sense."
>
> *— Jim Hutchins, Hackett Middle School, Albany, New York*

KIDS Consortium and the Maine Mathematics and Science Alliance offer a range of opportunities from on-site customized programs (which can inspire a stronger school-wide commitment to service-learning and CTS) to workshops and institutes that provide intensive training for individuals or smaller teams of teachers. See the inside front cover of this guide for more information.

> "CTS is a thoughtful and comprehensive way to align standards and developmental research around any given science topic, and I have found it to be invaluable for assessing curriculum and instruction. I shared CTS with our school science department and, with support from the Maine Mathematics and Science Alliance, science teachers from sixth to eighth grade are now using CTS to plan and refine units. Teachers post their thinking about units online to share and get feedback from each other."
>
> *- Rob Lindsay, Lincoln Middle School, Portland*

"Through expert support and guidance from KIDS Consortium, I have learned that it is critical for teachers to engage in ongoing professional development as service-learning practitioners, and the best form is often reflective practice sessions. The teachers try something, they reflect on what they did, they listen to what others have done,and they give and receive feedback --which helps them in their next service-learning experience. No two service-learning projects are the same, and the more they can talk to others about their practice, the stronger their practice becomes. Even experienced service-learning practitioners experience the benefits of time spent reflecting with other teachers."

— Joanne C. Harriman, Assistant Superintendent, Mount Desert Island Regional School System, Maine

For students, STEM/service-learning projects offer an engaging way to acquire critical skills and knowledge while gaining confidence and self-esteem through active work to improve their schools and communities. Students engaged in the YACS initiative often reflected on how transformative their experience was—convincing them that they could make a lasting impact on their home communities and the world at large.

"I can't believe I didn't know about this issue before we started this project. It makes me wonder why I never thought of it before and how so many people out there must be like me. If I could inform them of what I know now, maybe they would be just as inspired as I am. That's how I can help change the world."

— Participating student at Crossett Brook Middle School, Duxbury, VT

Appendices

Assess Your Service-Learning Practice

Service-learning actively engages participants in meaningful and personally relevant service activities.	Meaningful Service	Weak	Needs Work	Strong
	1. Service-learning experiences are appropriate to participant ages and developmental abilities.			
	2. Service-learning addresses issues that are personally relevant to the participants.			
	3. Service-learning provides participants with interesting and engaging service activities.			
	4. Service-learning encourages participants to understand their service experiences in the context of the underlying societal issues being addressed. What green schools issue/problem did you address?			
	5. Service-learning leads to attainable and visible outcomes that are valued by those being served. What green impact did you make on your school?			
	Overall rating of Standard			

Service-learning provides youth with a strong voice in planning, implementing, and evaluating service-learning experiences with guidance from adults.	Youth Voice	Weak	Needs Work	Strong
	1. Service-learning engages youth in generating ideas during the planning, implementation, and evaluation processes.			
	2. Service-learning involves youth in the decision-making process throughout the service-learning experience.			
	3. Service-learning involves youth and adults in creating an environment that supports trust and open expression of ideas.			
	4. Service-learning promotes acquisition of knowledge and skills to enhance youth leadership and decision-making.			
	5. Service-learning involves youth in evaluating the quality and effectiveness of the service-learning experience.			
	Overall rating of Standard			

Assess Your Service-Learning Practice *(cont.)*

Service-learning is intentionally used as an instructional strategy to meet learning goals and/or content standards.	Link to Curriculum	Weak	Needs Work	Strong
	1. Service-learning has clearly articulated learning goals.What were the STEM learning goals?			
	2. Service-learning is aligned with the academic and/or programmatic curriculum. What district and national resources did you use to align?			
	3. Service-learning helps participants learn how to transfer knowledge and skills from one setting to another. What specific STEM concepts and skills did students apply to implement their SL project?			
	4. Service-learning that takes place in schools is formally recognized in school board policies and student records.			
	Overall rating of Standard			

Service-learning incorporates multiple challenging reflection activities that are ongoing and that prompt deep thinking and analysis about oneself and one's relationship to society (Green Schools Issues/ Problems).	Reflection	Weak	Needs Work	Strong
	1. Service-learning reflection includes a variety of verbal, written, artistic, and nonverbal activities to demonstrate understanding and changes in participants' knowledge, skills, and/or attitudes.			
	2. Service-learning reflection occurs before, during, and after the service experience.			
	3. Service-learning reflection prompts participants to think deeply about complex community problems and alternative solutions.			
	4. Service-learning reflection encourages participants to examine their preconceptions and assumptions in order to explore and understand their roles and responsibilities as citizens.			
	5. Service-learning reflection encourages participants to examine a variety of social and civic issues related to their service-learning experience so that participants understand connections to public policy and civic life.			
	Overall rating of Standard			

Assess Your Service-Learning Practice *(cont.)*

Service-learning partnerships are collaborative, mutually beneficial, and address (green school) community needs.	Meaningful Service	Weak	Needs Work	Strong
	1. Service-learning involves a variety of partners, including, youth, educators, families, community members, community-based organizations, and/or businesses.			
	2. Service-learning partnerships are characterized by frequent and regular communication to keep all partners well-informed about activities and progress.			
	3. Service-learning partners collaborate to establish a shared vision and set common goals to address community needs.			
	4. Service-learning partners collaboratively develop and implement action plans to meet specified goals.			
	5. Service-learning partners share knowledge and understanding of school and community assets and needs, and view each other as valued resources. **What green knowledge/resources did community partners share with students?** **What green knowledge/resources did students share with partners?**			
	Overall rating of Standard			

Service-learning promotes understanding of diversity and mutual respect among all participants.	Diversity	Weak	Needs Work	Strong
	1. Service-learning helps participants identify and analyze different points of view to gain understanding of multiple perspectives.			
	2. Service-learning helps participants develop interpersonal skills in conflict resolution and group decision-making.			
	3. Service-learning helps participants actively seek to understand and value the diverse backgrounds and perspectives of those offering and receiving service.			
	4. Service-learning encourages participants to recognize and overcome stereotypes.			
	Overall rating of Standard			

Assess Your Service-Learning Practice *(cont.)*

Service-learning engages participants in an ongoing process to assess the quality of implementation and progress toward meeting specified goals, and uses results for improvement and sustainability. **Where/how did students use data to inform their progress?**	**Diversity**	**Weak**	**Needs Work**	**Strong**
	1. Service-learning participants collect evidence of progress toward meeting specific goals and learning outcomes from multiple sources throughout the service-learning experience.			
	2. Service-learning participants collect evidence of the quality of service-learning implementation from multiple sources throughout the service-learning experience.			
	3. Service-learning participants use evidence to improve service-learning experiences.			
	4. Service-learning participants communicate evidence of progress toward goals and outcomes with the broader community, including policy-makers and education leaders, to deepen service-learning understanding and ensure that high quality practices are sustained.			
	Overall rating of Standard			

Service-learning has sufficient duration and intensity to address (green school) community needs and meet specified outcomes.	**Duration & Intensity**	**Weak**	**Needs Work**	**Strong**
	1. Service-learning experiences include the processes of investigating community needs, preparing for service, action, reflection, demonstration of learning and impact, and celebration.			
	2. Service-learning is conducted during concentrated blocks of time across a period of several weeks or months.			
	3. Service-learning experiences provide enough time to address identified community needs and achieve learning results.			
	Overall rating of Standard			

This chart was adapted with permission from Assessing and Improving Your Service-Learning Practice (2008), a publication of the Institute for Global Education and Service-Learning (www.igesl.org).

KIDS Framework Planning Sheet

Reflection

Goal: make connections between the project and the learnings of the students

Collaborative Environment

Goal: create effective teamwork among class members

Public Relations

Goal: make sure the public is aware of the project

Celebration

Goal: build ongoing enthusiasm for the project and recognize accomplishments

Curriculum, Instruction and Assessment

Goal: connect the service-learning project directly to curriculum, instruction and assessment

Define Service-Learning

Goal: understand service-learning

Discover Needs/Problems

Goal: identify relevant and interesting needs/problems

Investigate Problems

Goal: investigate cause and effect of the identified problems

Research Solutions

Goal: identify and research possible solutions

Decide on a Project

Goal: evaluate solutions and select a project

Plan the Project

Goal: create an action plan for the project

Implement the Plan

Goal: put a plan into action and complete the project

Evaluate the Impacts

Goal: evaluate the impacts of the project

Notes

Notes

“What I like most about service-learning projects is that students get a real experience of the scientific inquiry process. Unlike a pre-determined lab experiment, students go through the process of research, which is essential to developing a hypothesis (solution idea). Students take ownership in the project and know that they are the ones making an impact… “

— *Christel Driscoll, Lincoln Middle School, Portland, Maine*

“I had never implemented service learning prior to this grant. Now, I am involved in three service learning projects! The way I teach is changing. Student voice plays a much bigger role in my classroom, as does democracy. Having students be such a part of their learning changes engagement entirely. Students found a place in school through service learning. Students learned what scientists do through the field trips, and through data collection.”

— *Melissa Williams, Crossett Brook Middle School, Duxbury, Vermont*

KIDS CONSORTIUM

Integrating Scientific Practices and Service-Learning:

Engaging Students in STEM

KIDS Consortium is a non-profit organization based in Maine that strengthens service-learning collaborations by preparing and connecting students, educators and community partners.

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Reach Beyond the Classroom...Transform Communities