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ABSTRACT

This document provides a framework for academic and career/technical teachers who want to raise students' achievement through real-life projects reflecting the rigorous academic and technical standards needed for further learning in the workplace and postsecondary education. The document begins with definitions of the six A's of project-based learning (authenticity, academic rigor, applied learning, active exploration, adult relationships, and assessment). The following core principles of project-based learning are discussed: (1) see the whole before practicing the parts; (2) study content and apply it to real problems; (3) learn by observing, trying out, and reflecting on how experts do things; and (4) make schoolwork more like real work. Questions for evaluating implementation of the six A's of project-based learning are listed along with the following action steps for translating research into action: (1) identify specific things students will learn through the project; (2) define an essential question/concept; and (3) design "scaffolding" (activities, access to resources, knowledge and skills, and assessments) to support learning. The following items are also included: suggestions for building a repertoire of

teaching skills; sources of staff development and technical assistance; a list of World Wide Web resources; profiles of five successful project-based learning programs; and a detailed example of gauging a project's effectiveness. (MN)

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HIGH SCHOOLS THAT WORK

Using Real-World Projects to Help Students Meet High Standards in Education and the Workplace

SITE DEVELOPMENT GUIDE #11

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Using Real-World Projects to Help Students Meet High Standards in Education and the Workplace

This guide provides a framework for academic and career/technical teachers who want to raise students' achievement by getting them to complete challenging, real-life projects. These projects should reflect rigorous academic and technical standards that students need for further learning in the workplace and postsecondary education. The guide was prepared by Jobs for the Future for use by the Southern Regional Education Board's High Schools That Work *sites and JFF's Connected Learning Communities.*

Introduction

- How can I convince students that they need to know this material?
- What can I do to make students see the importance of state and local standards?
- How can I engage students in learning and motivate them to persist when the work is hard?
- Who in the school and community will be my allies in creating meaningful learning experiences?

Teachers puzzle over these questions, but they don't find easy answers. Many teachers say using authentic, community-connected projects is effective in raising students' academic and technical performance, and this guide focuses on that strategy.

Project-based learning invigorates students and teachers by showing how academic and technical content and skills are applied in the "real world." Projects allow students to test their ideas in the company of supportive adults who push them to excel.

SREB research has shown that students benefit most from completing projects that are planned jointly by academic and career/technical teachers, preferably during common planning time carved into the school schedule.[1] Collaboration enables teachers to align their learning objectives for students, blend academic and career/technical studies to reflect "real life" more accurately, and motivate students to achieve in both academic and career/technical classrooms.

The six A's of project-based learning

In working with high schools nationwide, the Southern Regional Education Board and Jobs for the Future have developed a definition of project-based learning that emphasizes the rigor and relevance of students' efforts. In this definition, project-based learning complements and connects two important trends in education:

- the use of external standards to guide changes in curriculum, instruction and organization; and
- the creation of community- and school-based opportunities for students to immerse themselves in the adult world of work and learning.

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1 *Working Together to Change Practice and Accelerate Student Learning: Lessons from Demonstration Sites Striving to Advance the Integration of Academic and Vocational Education.* Dave Emanuel, Nicole Joyner and Denise Bradby of MPR Associates Inc., with Betty Creech and Gene Bottoms of the Southern Regional Education Board. 1998.

Adria Steinberg of Jobs for the Future wove both trends into the following criteria for quality project-based learning:

Authenticity — Projects use the context of the workplace and the community to teach academic and technical skills.

Academic rigor — Projects require higher-order thinking skills and research methods from academic and technical fields.

Applied learning — Projects require students to use academic and technical knowledge in acquiring the problem-solving, communication and teamwork skills they will need in the workplace.

Active exploration — Projects extend beyond the classroom to involve work-based learning, community-based activities and technical labs.

Adult relationships — Projects involve adult mentors from the school and the community.

Assessment — Projects include exhibitions and assessments of students' work according to personal standards and performance standards set by the school and the community.

The six A's apply to all projects, regardless of whether they originate inside or outside the classroom. Projects that originate from academic content can extend into the workplace, the community and technical labs. Projects that originate from real-life problems can connect back to academic and technical studies and let students practice using these vital skills.

Why projects? What do experience and research teach us?

Teachers need only to remember their own schooling to verify the value of project-based learning. When asked to identify their most meaningful or memorable learning experience from middle school or high school, many adults describe extended, complex projects: a play written, directed and produced by an eighth-grade humanities class; a report by a chemistry class on possible toxins in a nearby pond; or a trip to Mexico to live with a family and study Spanish. When researchers from Jobs for the Future and *High Schools That Work* ask students to share their "best-quality" work, they see similar kinds of products and performances: a model rocket, a business plan for a school radio station, or a videotape of campaign ads for candidates in recent elections.

Students take pride in producing or doing something that has value beyond the classroom. Such projects diverge from the typical school fare of absorbing and regurgitating bits of knowledge. Worksheets, chapter reviews, oral recitations and tests certainly can reinforce students' skills and knowledge. However, students can become passive and cynical if they are confronted with these teaching strategies hour after hour, day after day.

In addition to anecdotal data, there is evidence that the results of traditional classroom practices may not be good enough. Although teachers work hard to cover the curriculum, too few students are gaining a deep understanding of what they are learning. A surprising number of even the "best" students continue to harbor misconceptions about core scientific topics, such as gravity or seasonal changes — topics that are taught and retaught in school. Furthermore, most students have difficulty transferring what they learn within the disciplinary boundaries and classroom contexts of school to other disciplines and contexts. If the purpose of school is to teach students material that they can use later, one would want them to apply what they have learned across school subjects and, ultimately, in their everyday lives.

The Six A's of Project-based Learning

Authenticity	Is the project based on a problem or question that is meaningful to the student?
	Is the problem or question one that an adult might tackle at work or in the community?
	Does the project provide the student with opportunities to produce something that has personal and/or social value beyond the school?
Academic rigor	Does the project cause the student to acquire and apply knowledge related to one or more disciplines or content areas?
	Does the project challenge the student to use research methods from one or more disciplines? (For example, does it cause him or her to think like a scientist?)
	Does the student develop higher-order thinking skills? (For example, does he or she search for evidence or seek a different perspective?)
Applied learning	Does the student solve (e.g., design a product, improve a system or organize an event) a problem that is grounded in life and work?
	Does the project require organizational skills and self-management?
	Does the project cause the student to learn and use skills (such as problem-solving, communication, technology and teamwork) that are expected in the workplace?
Active exploration	Does the student spend a significant amount of time doing field-based work?
	Does the project require the student to use various methods, media and sources to conduct an investigation?
	Is the student expected to make a presentation to explain what he or she has learned?
Adult relationships	Does the student meet and observe an adult who has relevant expertise and experience?
	Does the student work closely with — and get to know — at least one adult?
	Do adults collaborate with each other and with students on the design and assessment of projects?
Assessment	Does the student use project criteria (that he or she helped establish) to gauge what he or she is learning?
	Do adults from outside the classroom help the student develop a sense of real-world standards?
	Is the student's work assessed regularly through methods such as exhibitions and portfolios?

The six A's of project-based learning are taken from the 1997 book *Real Learning, Real Work: School-to-Work as High School Reform*, by Adria Steinberg.

The following core principles are emerging from research on conditions that promote effective learning and equip people to apply knowledge appropriately in new situations:

- **See the whole *before* practicing the parts.** Young children see their parents walk before their own motor skills begin to develop. Apprentices in a tailoring shop learn to assemble a garment from precut pieces before they learn to cut out the pieces themselves. In these situations, the learners see the whole before they work on the parts. Yet this is rarely the case in school. As one student said, "In school, I do little pieces of everything, but they don't really stick in my brain." Researchers say it is important for students to develop a feel for — and a conceptual map of — the overall terrain. The teacher then can begin to incorporate the skills and concepts necessary for expert performance and can teach students to identify conditions under which various skills and strategies apply.

- **Study content and apply it to real problems.** Expertise consists not only of knowing concepts, information and procedures but also of being able to apply them to problems. At the work site, adults draw on knowledge of both content and process. However, high school students spend most of their time learning content (e.g., significant events in American history, the stages of cell mitosis or quadratic equations) and almost no time learning problem-solving strategies and thinking processes. Classroom knowledge is inert rather than dynamic; students often do not develop the ability to make sense of information and think about how and when to use it. Researchers have found that knowledge does not transfer if students do not learn problem-solving strategies and processes as well.

- **Learn by observing, trying out and reflecting on the way experts do things.** Before young children walk or talk, their parents use tried and true teaching methods to put them through an informal apprenticeship. Parents demonstrate the activity; coach the child and cheer as he takes a few steps, falls down and tries again; support the learning by pronouncing correctly the words the child is attempting to say; and, ultimately, fade into the background as the child accomplishes more and more. Researchers have found that teachers need to employ several other teaching methods in addition to these basic principles. For example, teachers should require students to express their reasoning or problem-solving processes through journals or periodic conferences. Teachers also need to ask students to reflect regularly on their own processes and assumptions, especially compared with those of experts and their peers and with their own interpretations of what the situation requires.

- **Make schoolwork more like real work.** Learning environments inside and outside of school differ in several important ways. For example, learning in school can be primarily an individual mental activity that requires little or no engagement with tools or materials. Learning outside of school often involves other people as well as available tools and materials. Learning in school depends heavily on symbol systems that are not related to things and situations that make sense to students; outside of school, thinking and actions are grounded in the logic of immediate situations. Fred Newmann and his colleagues at the University of Wisconsin studied the way 24 schools taught mathematics and social studies. After setting standards for teaching and learning (which had characteristics similar to those emphasized in the six A's), the researchers found that students' scores on standardized tests and alternative assessments were higher if their classes involved work that resembled real situations.

Translating research into action — tweaking assignments

The challenge for teachers is to translate research into learning activities for students. School- and community-connected projects — as defined by the six A's — incorporate the research-based characteristics of effective learning in a "classroom-friendly" way. Any teacher can use the six A's to modify learning activities and engage students in projects that will deepen their understanding and help them develop thinking processes and strategies for applying their knowledge.

Teachers can begin by tweaking assignments they already make. For example, a history teacher in Oregon's North Clackamas school district was not satisfied with students' work on end-of-term research papers on 20th-century American history and culture. Working with the six A's, she realized that a few minor changes would improve the rigor and relevance of the assignment. She added a requirement that students write an abstract, a step taken by real historians when they present their research. She also encouraged students to interview an expert on the topic. Students who did so found that these interviews helped them in unexpected ways.

"The interview with an expert helped me — and anyone reading my research paper — to understand my topic better. After the interview, I was able to put the pieces together. The examples and themes that the expert brought to my attention caused me to alter my report. It helped me see that many of the things I had singled out could be combined," one student said.

In the same Oregon school district, a physics teacher used a similar process. For several years he had asked students to use what they learned in designing and building model bridges. The team of students that built the strongest bridge won the design competition. After working with the six A's, the teacher made a simple but profound change: He asked each team to develop a hypothesis related to a model bridge's strength and then to design an experiment to test the hypothesis. The activity still involved designing and building, but now it also caused students to apply physics principles and practice real-life physics skills through their experiments and lab reports. Pleased with the results, the teacher upped the ante again by requiring teams to post their lab reports (including scale drawings of their bridges) on a Web page.

Translating research into action — planning a new project

The six A's also can help teachers plan a project from scratch. Two particular A's — authenticity and academic rigor — are essential to developing a high-quality project. Teachers should create projects that have relevance for students and should strive to have students achieve high academic standards.

Project ideas come from different sources, and projects develop in different ways. There is not one "correct" way to design a project, but there are common elements that go into designing effective projects. Jobs for the Future has identified three major actions that are essential to the process.

Action 1: **Why this project? Identify specific things that students will learn through this project.**

A high-quality project provides a rich context for students to learn and apply the material, concepts and problem-solving skills that they are learning in their academic and career/technical courses. In planning a project, it is important to identify its specific learning goals and to map out how these goals connect to the local, state and national standards for knowledge and skills that students are expected to meet.

Many standards require higher-order thinking skills and in-depth exploration of a topic. For example, national standards — such as the National Science Education Standards developed by the National Center on Education and the Economy and the academic standards developed by the Council for Basic Education — urge teachers to help students gain a deeper understanding of material rather than stop at memorizing facts. Such documents emphasize the importance of understanding, reasoning and problem-solving.

By considering both how to address the standards and how to build on students' interests, teachers can plan rigorous projects that require diverse skills and can engage students from the beginning of a unit. For example, a health sciences teacher at Brighton High School in Boston, Mass., considers standards and relevance to students' lives before starting a project. While teaching students about 16th-century medicine, she asked them to research old family remedies. She wanted to teach them that medicine is practiced at home, not just in hospitals, and that understanding science and medicine is important for everyone.

In identifying the standards that particular projects will help students meet, teachers can get inspiration and assistance from several sources, including:

- Other teachers — Academic and career/technical teachers can work together to develop a question that is both rigorous and relevant in strengthening students' academic and technical skills. This approach fosters professional relationships among teachers from different fields and helps them learn what students need to know in other courses. Collaboration enables teachers to align their instructional objectives and better prepare all students for the workplace and further education. Teachers who work and plan together — in a block of time during the school day or on their own time before or after school — raise student achievement by utilizing all resources in developing student projects.
- Community partners — By spending time in local businesses and industries, teachers improve their ability to connect what is taught in the classroom with what is needed in the work force. Good preparation for project development involves meeting with local employers and visiting work sites to identify how academic knowledge is applied in the workplace. The duration of such visits can range from one or two days to an extended internship for teachers. (See the *High Schools That Work* site development guide No. 8, *Teachers in the Workplace: A Staff Development Approach That Benefits Faculty and Students.)*

One way to open conversation between teachers and community partners is to focus on how academic skills are applied in the workplace and what broad skills employees need. How is mathematics applied? How are writing skills used? What communication skills do employees need? How do employees use resources, technology and information systems?

Action 2. Define an essential question or concept.

A good project involves serious research. The essential question or questions need to be:

- interesting to students;
- similar to something that would come up in the workplace; and
- related to academic and technical standards.

A teacher either can generate an essential question or questions in advance (with help from other teachers and community partners) or can get students to brainstorm in class. Involving students in determining the questions will help them feel more a part of the project.

In determining questions for projects to address, teachers, community partners and students may wish to ask:

- What things in your community would you like to help change?

need to ensure that students have the academic and technical knowledge and skills to complete their projects.

The following guidelines can help teachers support students in completing projects:

- **Set explicit expectations and criteria.** Give students clear guidelines for planning their projects. They need to know exactly how and when their work will be evaluated. (Ideally, students should help to set evaluation criteria.) Project guidelines are not the same as instructions. While instructions tell students exactly what to do, guidelines help them plan and conduct their projects. Teachers need to ask:
  - Are the guidelines clear?
  - Do students know how and when their work will be assessed?
  - Were students involved in setting the assessment criteria?
- **Provide access to essential resources, knowledge and skills.** Teachers can point students toward varied materials — more than just books and articles — that will help them complete their projects. These information sources can include examples of projects for students to use as models; teachers and community mentors and "coaches" who can answer questions about the field; and the technology needed to carry out the projects. Teachers should ask:
  - Can students see examples of work that other students have done on similar projects?
  - What academic and technical knowledge will students need to complete the project?
  - Do students have mentors or "coaches" to support the projects' field-based elements?
  - Do students have access to the technology necessary to complete the research and exhibition phases of the projects, and do they know how to use it?
- **Conduct ongoing assessment and continuous feedback.** By setting deadlines for certain phases of the projects, teachers establish milestones that enable them to conduct ongoing assessment. These milestones keep student projects on track, divide a large project into manageable tasks and make schoolwork seem more like a real job, in which projects typically involve more than one task. Ongoing assessment enables students to adjust their projects to meet expectations. It also is helpful for various sources — including mentors, "coaches" and peers — to assess the projects and for students to assess their own progress periodically. Teachers should ask:
  - Do checkpoints mark the end of each phase of the projects?
  - Are students expected to meet certain milestones while working on their projects?
  - Do students engage in periodic, structured self-assessment?
  - Do they receive timely feedback on their works-in-progress from teachers, mentors and peers?

Building a repertoire of teaching skills

Designing high-quality projects that are relevant to students' lives involves several important teaching skills. Teachers need to know how to formulate essential questions that provide a starting point for students; identify teachers and community members who can relate the projects to real issues and problems; get students to work productively in small groups and on their own; and use journals and other "process checks" to help students make steady progress. Schools and districts need to design coherent, sustained professional development that focuses on helping teachers build a repertoire of skills.

Staff development and technical assistance help teachers engage students in projects

The Jobs for the Future's Connected Learning Communities faculty of nationally known experts in project-based learning has designed a way to engage teachers in using projects to raise student achievement. Teachers attend an intensive three- to four-day seminar that immerses them in projects, enables them to see firsthand the knowledge and skills that can be learned in real-world settings, helps them to analyze exemplary projects, and gives them the opportunity to engage in the first stages of project design. Just as a teacher at times may need to provide specific instructions to students, the consultant sometimes offers explicit instruction in a skill, such as forming productive working groups or introducing students to the problem-solving strategies upon which their work will be based.

During the school year, the consultant visits schools periodically and helps teachers to overcome challenges in implementing projects and to use assessment and other methods in teaching students the needed background knowledge and skills. The consultant also helps teachers create opportunities to showcase students' work. After teachers have implemented projects successfully, the consultant helps them figure out how the changes affect their students and how they can gather evidence of the impact on student learning.

School sites work with consultants to customize project-based learning for their needs. It is important to emphasize both "why" and "how" project-based learning works and to give teachers adequate support in changing how they teach. This support needs to include sustained professional development as well as the alignment of professional development with the school's accountability measures for teaching and student learning.

The Southern Regional Education Board's *High Schools That Work* initiative provides a series of national professional-development programs each year. All of these programs — which include sessions on project-based learning — are designed for teams made up of teachers and leaders in the school and school system.

High Schools That Work also has developed a menu of staff development activities that states and sites can use in conducting their own training. Some programs offer preparation for teachers who want to become trainers.

High Schools That Work links states and schools with teachers and administrators who are qualified to help them carry out the *HSTW* key practices for improvement of schools and classrooms. *HSTW* maintains a database of approved trainers and providers of technical assistance and helps schools identify people who can fill local and regional needs for staff development.

The same principles of learning that work with students hold true for teachers. Both groups need to see the "whole" before they work on the parts. Some teachers might want to start with something "packaged"; as noted earlier, some teachers begin by adding a new element to an existing assignment. They also can find ideas on the World Wide Web and in manuals that contain project descriptions, such as *Project-based Learning: A Strategy for Teaching and Learning* (W. Diehl, et al. Center for Youth Development and Education, January 1999).

Many teachers find it helpful to do an "apprenticeship" in project design by working with an experienced colleague. Some schools in *High Schools That Work* and Jobs for the Future's Connected Learning Communities hire consultants to train teachers in designing projects and support them in implementing projects.

The future of project-based learning

As states and districts set new, higher standards of achievement, schools can and should rethink what and how they teach. One thing is clear: The status quo will not suffice. While traditional curricula and methods of instruction work for some students, many others leave high school unprepared for jobs or further education. Working harder to do a better job teaching with the same content and methods will not result in higher student achievement.

Jobs for the Future and *High Schools That Work* offer schools an alternative approach: Enroll all students in an upgraded academic core that prepares them for college and careers, and use strategies such as project-based learning that will engage students and make high-level academic and technical content meaningful.

Project-based learning can help students learn the content, skills and personal qualities they will need in college or in careers. Project-based learning does not replace high-quality direct instruction, and it is not the only way to provide student-centered instruction. When it is used well, project-based learning can add meaning and purpose to school assignments, motivate students to learn more

Web resources

Autodesk Foundation	www.autodesk.com/foundation/pbl/pbl.htm
TERC Projects	www.terc.edu/projects/projects.html
Illinois Mathematics and Science Academy's Center for Problem-Based Learning	www.imsa.edu/team/cpbl/cpbl.html
Cornell Youth and Work Program: Learning Through Projects	www.human.cornell.edu/youthwork/ptools/learn/
Collaborative Learning Environments On-line	http://cleo.terc.edu/cleo/cleo-home.cfm
ThinkQuest Library of Entries	http://library.advanced.org/library/index.html
High Schools That Work Outstanding Practices	www.sreb.org
Jobs for the Future	www.jff.org

advanced material, provide practice in essential skills for lifelong learning and help students see the practical applications of what they learn.

Some teachers worry that states' new high-stakes tests will undermine project-based learning. To overcome this fear, districts need to be committed to sustained professional development and project-based instruction, according to Jobs for the Future's research in its Connected Learning Communities initiative. In school districts that have demonstrated this commitment, teachers view projects as an excellent, efficient way to help students meet higher standards.

As part of the Connected Learning Communities initiative, teachers collect evidence on the effectiveness of their own efforts to try new practices. For example, teachers in North Clackamas, Ore., not only made their assignments more rigorous and relevant to the workplace but also studied how these changes affected students. After designing projects that caused students to do things differently, teachers identified which practices or aspects of the projects made a difference for students. Then they developed two or three ways to gather evidence of the impact.

Putting physics reports on the Internet

At North Clackamas High School in Oregon, a physics teacher used the state's scoring guide for lab reports to compare students' traditional lab reports with ones they did for Web pages. He found that most students scored considerably higher when they wrote the reports for their Web pages. He attributed this fact to students' personal investment in writing the reports and to their desire to make the Web pages as understandable as possible for an outside audience. The data showed several improvements:

- Students wrote clearer research questions and better-reasoned hypotheses.
- The Web page reports were more detailed and provided a better sense of the subtleties and difficulties of creating a truly scientific experiment to test a research question.
- Students achieved at a higher level.
- Students generally found more meaning in their work and were more careful to use appropriate scientific vocabulary and concepts.

Amid the current focus on accountability, teachers need to document how an instructional change affects student learning. Such documentation reassures teachers that they are on the right track and persuades districts and schools to support teachers' efforts, even if it means some fairly substantial changes in school organization.

Teachers, students and the community all benefit when project-based learning is connected to high-level academic and technical content and teachers engage students in learning. Students and teachers will be more motivated, and students will achieve at higher levels.

Evidence-driven change in the classroom: Using research to improve practice

By examining and documenting how changes in classroom practices affect students, teachers strengthen the connection between teaching methods and student achievement. They develop a deeper understanding of finding evidence of learning, and they use research methods to find this evidence and draw conclusions about the links between teaching practices and student learning.

Jobs for the Future uses several questions to guide this approach:

- **What are the main results you want to achieve in student learning?** Develop one or two learning goals that instruction will address.
- **What is your instructional design?** What project and learning approach will you use to help your students achieve at a higher level?
- **What is the evidence?** How will you know that your instruction has resulted in improved student learning? Which measures will you use to gauge success?
- **What evidence do you want to quantify and examine more closely?** What pieces of evidence do you want to link more directly to your teaching? What evidence are you most interested in exploring? Decide how to gather and assess this evidence.
- **What does the evidence tell you about student learning and about your teaching?** What have you learned about overall student achievement, individual growth and students' opinions about their learning experiences?
- **Based on your evidence, what changes would you make to improve student achievement?**

Sources: Cheryl Almeida and Michelle Swanson, Jobs for the Future faculty.

Project examples

The Bald Hill Park project

Students in an Advanced Field Biology class at Crescent Valley High School in Corvallis, Ore., conducted an eight-month study of Bald Hill Park's biological and cultural resources. The project was designed to combine academic study and community service.

Students were divided into seven four-person teams to research topics such as birds, mammals, insects, geology, cultural history, streams and plants. More than 20 mentors from the community advised the students as they collected specimens, dug plants, and navigated the streams and land in the park. Students used their findings to write a guide to the park's biological, geological and cultural richness. Sections of the guide were used in displays at the park entrance.

Students also led field trips for about 150 residents of the area and produced a video about the Native Americans who once lived where the park now stands. That video has been used in a Native American studies class at Oregon State University.

High-level mathematics and science put students' pedal cars on "fast track"

At Swain County High School, a *High Schools That Work* site in Bryson City, N.C., a technology teacher and a mathematics teacher organized students into two teams to build the fastest pedal cars possible from scrap materials. The students interviewed local experts and conducted research at the library and on the computer. They studied the aerodynamic shapes of various car designs and later used actual tests to verify their conclusions.

Students applied concepts of perimeter, area and volume to estimate the amount of materials they would need to build the cars; they used their geometry skills to produce the frame and the cover. They devised a plan for a wheel base that could transfer energy from the pedals to the wheels. Then they calculated how many revolutions were needed to move 50 yards and the correlation between crank speed and vehicle speed. The students conducted full-scale tests of the cars, collected data to determine whether the cars were achieving maximum performance and made improvements.

Students also factored in the size of the driver and variables such as weight and leg power. They designed models and used their analytical skills to confirm hypotheses about how the driver's physical characteristics would affect the car's speed.

Students put the cars through many practice runs as they refined their designs. For the final assessment, students demonstrated their cars and presented oral and written explanations of the design process.

The project's open-ended nature invited students to explore multiple strategies. They were free to generate and test theories, evaluate results of experiments, and modify their designs throughout the construction process.

Students kept a daily log to record their progress, adjustments they needed to make, and findings about how changes to the design affected the car's performance.

To enhance the project, students were given the option of setting up a pulley system driven by a DC motor operating at a constant speed. They could measure and record the speed of the motor shaft and pulleys and then use the data to draw conclusions about the performance of motorized vs. pedal-powered vehicles. Students also could install an electrical system, including lights and a horn, in their cars and could convert the cars to gasoline, electric and/or solar power.

Schoolwide forestry project takes root in Louisiana

A schoolwide project at Caldwell Parish High School in Columbia, La., strengthened connections between vocational and academic disciplines and helped students and teachers to focus on the local forestry industry, one of the community's two largest employers. (Farming is the other.)

Students learned a lot about job opportunities, industrial practices, forestry equipment and the uses of timber and timber products. They conducted research and used mathematics and science in solving actual problems.

The project originated in the agri-science department, where teachers realized that students needed to learn more about forestry careers and the academic skills required for jobs and college programs in this field. These teachers enlisted the help of all academic and vocational teachers in planning and conducting the project.

The planning team met with a local forester, who helped design the project and coordinated special activities with officials in the forestry industry. The project was supported by International Paper

15

Co., Stone Container Corp., the Louisiana Department of Agriculture and Forestry, the National Resource Conservation Service, the Louisiana Machinery Co. and the Rowland Timber Co. Fifteen foresters from the area made presentations at the school.

Teachers prepared for the weeklong event by participating in staff development on forest ecology and environmental issues. They wrote integrated lesson plans that contained forestry-related projects. In mathematics, students were asked to estimate board feet of trees and to use graphs in determining trees' heights and ages. In science, students learned about the growth and development of certain species of trees. In social studies, students did research and prepared reports on the history and economic impact of forestry in Caldwell Parish.

The integrated effort featured a school-based enterprise that addressed all aspects of creating, developing and marketing a product. Three departments — agri-science, biology and English — organized a company to grow and sell tomato plants. Students became stockholders and elected a board of directors, and every student had a job in the company.

Outside of class, students planted trees and garden plants; worked on the tomato plant business; and wrote research papers, essays and poems. Students gathered information for the project from foresters in the community, parents and acquaintances and from visits to local woodlands.

At the end of the week, local business partners sponsored demonstrations of forestry equipment, including timber loaders, log trucks, firefighting and soil-testing equipment, and survey instruments.

Teachers evaluated students' projects and conducted a survey of students' reactions to the forestry emphasis. They found that students scored above average on projects and exams related to the project. They also discovered that students gained broader and deeper knowledge, made connections between academic and vocational studies, saw how academic learning is applied in the workplace, and showed more enthusiasm for learning.

Living History Day

Living History Day, a schoolwide project at Milwaukie High School in Milwaukie, Ore., began in 1995 to mark the 50th anniversary of the end of World War II. The project, which has become an annual opportunity for all students to study the history and people of American conflicts, culminates in a daylong Veterans Day observance.

Months before Veterans Day, students begin contacting veterans who can speak on particular topics, such as Pearl Harbor or the Holocaust. They also contact organizations that can provide authentic military equipment and re-enactment displays. Students sell engraved dog tags to raise money for the event.

Teachers prepare for Living History Day by incorporating relevant information and activities into their lesson plans. For example, the American Studies class spends several days studying the Holocaust and reading literature about war times. Students in speech classes write and deliver presentations based on veterans' memories of World War II. Students in band classes learn music that was popular during the war years. All students are expected to do research and generate questions to ask veterans.

Living History Day begins with an assembly, during which veterans are escorted into the auditorium by students and are honored formally. Each student attends two panel discussions, in which students ask questions and take notes on the veterans' experiences. After lunch the veterans are treated to a USO-type show that features patriotic music played by the school band and war-era skits performed by students.

16

After Living History Day, students in a creative writing class publish a booklet of their stories and poems inspired by the project. All students write thank-you notes to the veterans as a writing assignment.

Integrated program works to solve local problems

In the agri-science program at Sumner High School in Sumner, Wash., instructors in agri-science, advanced biology and graphic communications developed an integrated program that incorporates academic, technical and personal skills. Each team of students selects a local problem that merits further scientific research. Students have been key players in major research efforts, such as controlling bacteria in poultry and cattle operations, identifying and controlling pollution, and replacing protein in animal embryos.

The teams get representatives from industry and/or higher education to serve as mentors as they design and carry out scientific projects related to the local problems. Each team uses computers in graphics and agriculture labs to prepare a visual display of its project and an oral and visual presentation.

The projects, which take at least a year to complete, are woven into other activities in the agri-science, advanced biology and graphic communications courses. The projects usually become multi-year endeavors that create several related projects. Many students get summer jobs or internships with their mentors in workplaces such as veterinary clinics, university research facilities, salmon hatcheries or processors and the Environmental Protection Agency. Research efforts have led to scholarships for many students, including some who had not planned to attend college but changed their minds because of the projects.

Extensive remodeling of the school's facilities gave the students access to a schoolwide computer network that enabled them to communicate with mentors nationwide by e-mail and fax.

Example of gauging a project's effectiveness

The following section is designed to help you examine a project's dimensions, adherence to the six A's of quality project-based learning, and support for student learning. The template will help you plan and assess the impact of your own projects. In the template, the evaluation of the sample project appears in italics.

The costs and benefits of health care models
Encina Health Careers Academy, Encina, Calif.

Encina High School serves a mostly urban, transient population in California's San Juan Unified School District. In an attempt to build a more stable environment, Encina High School created several "academies" — or schools-within-schools — to provide a focus for academically rigorous programs of study.

These academies represent broad industry clusters, such as health careers, business careers and the arts (performing and visual arts as well as graphics and printing). The health careers academy, established in 1990 with a grant from the state, has strong links with Sutter Community Hospitals, Western Career College and Mercy Healthcare Sacramento. Students in the academy take the core academic courses as well as health-based courses and activities that teach them about medical terminology, community service and portfolio maintenance.

In an age of managed care that may not reimburse families for health services provided by school clinics, the question became, "How can health care be delivered seamlessly at the school site?" Several years ago Encina High School's health careers academy and Sutter Community Hospitals formed a partnership to explore the question through an extended student project.

Project implementation

Students (mainly seniors) involved in the project were enrolled in the following three courses: Economics and U.S. Government; English IV; and Health Technology III. Teachers of the three courses aligned their curricula to teach the skills required to complete the project. For example, early in the school year the Economics and U.S. Government instructor covered research methods in the social sciences; likewise, the English instructor taught how to create bibliography cards while doing a literature search. Even though they were not involved formally in the project, faculty in the computer laboratory helped students access electronic information.

Students worked together throughout the year to conduct thorough cost/benefit analyses of the community's various options in establishing accessible health care. Students did research in the library and on the Internet, but most of their information came from interviews with administrators and staff at Sutter Community Hospitals. The students also interviewed personnel in the mayor's office and the California Department of Health Services and did research there.

Every Friday, the Health Technology III course was dedicated to work on the project. Students heard from health industry representatives, discussed project issues and logistics, and reflected on what they were learning. Every other week students were expected to turn in some portion of the project (bibliography cards, online search results, explanations of procedures and methods used, data gathered, and conclusions). Requiring the students to turn in some work every other week and devoting Fridays to work on the project gave students opportunities to check their progress and refine their approaches. Industry representatives came to campus biweekly to review students' work and recommend improvements.

At the end of the project, students analyzed the strengths, weaknesses, opportunities and threats of each option for health care. Each student submitted a written report, and the class as a group made an oral presentation. Members of the Sutter Community Hospitals Foundation Board assessed the work and the students' findings. Students' recommendations were considered when the hospital revised its strategic plan for community-based medical clinics.

18

Project name: The Costs and Benefits of Health Care Models

I. Project dimensions

Group size: *Students work together as a class but do some work as teams or individuals.*

The class does the same project together.	The class breaks into small teams, each of which does a project.	Each student does his/her own project.

Method of devising project structures and topics: *determined largely in advance by adults, with student input*

Assigned by teacher	Negotiated between student and teacher	Determined by the student, with teacher approval

Duration: *a whole year*

Several days	Several weeks	Full semester or year

Integration of subjects: *Three courses — Economics and U.S. Government, Health Technology III, and English IV — are involved in the project.*

Involves one subject area	Integrates two subject areas	Integrates more than two subject areas

II. The six A's of quality projects

Authenticity	In this project
1. Is the project based on a problem or question that is meaningful to the student?	1. *About 85 percent of Encina High School students have families that receive Aid to Families with Dependent Children (AFDC) support. These students have a vested interest in the proper delivery of health care.*
2. Is the problem or question one that an adult might tackle at work or in the community?	2. *The emergence of managed health care has created a cottage industry of professionals in policy analysis and health care services.*
3. Does the project provide the student with opportunities to produce something that has personal and/or social value beyond the school?	3. *The Foundation Board received the recommendations and took them seriously.*

Authenticity overall: *The project adhered to this standard directly and completely.*

19

Academic rigor	In this project
1. Does the project cause the student to acquire and apply knowledge related to one or more disciplines or content areas?	1. *The project involves work for three courses: Economics and U.S. Government, Health Technology III and English IV.*
2. Does the project challenge the student to use research methods from one or more disciplines?	2. *The project's length (a full year) enables students to employ rigorous research methods in conducting cost/benefit analyses.*
3. Does the student develop higher-order thinking skills?	3. *The project blends complex issues related to the delivery of health care with local social issues.*

Academic rigor overall: *The project adhered to this standard directly and completely.*

Applied learning	In this project
1. Does the student solve a problem that is grounded in life and work?	1. *The issue of access to health care is complex and all too real for many people.*
2. Does the project require organizational skills and self-management?	2. *The blend of group work and individual work helps students develop complex project-management skills.*
3. Does the project cause the student to learn and use skills (such as problem-solving, communication, technology and teamwork) that are expected in the workplace?	3. *Students increase their skills by working together as a class, developing quality recommendations and presenting them, and grappling with the complex problem at the root of the project.*

Applied learning overall: *This project adhered to this standard directly and completely.*

Active exploration	In this project
1. Does the student spend a significant amount of time doing field-based work?	1. *Students conduct interviews, much of which cannot take place during class time.*
2. Does the project require the student to use various methods, media and sources to conduct an investigation?	2. *Students interview experts, use the library and the Internet, and plan and deliver presentations.*
3. Is the student expected to make a presentation to explain what he or she has learned?	3. *Students report progress biweekly to teachers and industry representatives and make a final report to a panel of adults.*

Active exploration overall: *The project was strong in most aspects.*

Adult relationships	In this project
1. Does the student meet and observe an adult who has relevant expertise and experience?	1. *Students meet with adults who act as consultants, but students do not necessarily observe these adults at work.*
2. Does the student work closely with — and get to know — at least one adult?	2. *The hospital puts considerable effort into arranging for students to conduct interviews and get exposure to the work site, but the project does not create intensive one-on-one student/adult relationships, especially outside of the hospital.*
3. Do adults collaborate with each other and with students on the design and assessment of projects?	3. *At the outset, students, teachers and industry representatives meet to design the project, establish objectives and predict results.*

Adult relationships overall: *The project was strong in most aspects.*

Assessment	In this project
1. Does the student use project criteria (that he or she helped establish) to gauge what he or she is learning?	1. *Reviewing what has been learned takes place throughout the project, but students do not appear to engage in regular self-assessment. Student input into criteria for assessment is limited.*
2. Do adults from outside the classroom help the student develop a sense of real-world standards?	2. *Community experts attend the project presentations; other representatives of the health care industry provide input throughout the year.*
3. Is the student's work assessed regularly through methods such as exhibitions and portfolios?	3. *Milestones are established clearly, and various media are used in assessment.*

Assessment overall: *The project adhered to the standard pretty well, but with gaps.*

III. "Scaffolding" — activities and assessments that will support learning

1. Explicit expectations and criteria

- Are the guidelines clear?
- Does the student know how and when his or her work will be assessed?
- Were students involved in setting the assessment criteria?

Expectations and guidelines were relatively clear from the start. Some students helped determine the scope of the project, but students could have contributed to the assessment criteria.

21

2. Resources

- Can the student see examples of work that other students have done on similar projects?
- Does the student have a mentor or "coach" to support the project's field-based elements?
- Does the student have access to the technology necessary to complete the research and exhibition phases of the project, and does he or she know how to use it?
- Does the student have access to instructional tools that allow him or her to learn the material and skills needed?

Students had limited access to research in the managed care field, but many resources were available from the participating health facilities. Students who do such projects in the future should make additional connections with members of the community. Valuable technology for research was available through a partnership with the faculty at a computer laboratory.

3. Ongoing assessment and continuous feedback

- Do checkpoints mark the end of each phase of the project?
- Is the student expected to meet certain milestones while working on his or her project?
- Does the student engage in periodic, structured self-assessment?
- Does he or she receive timely feedback on the work-in-progress from teachers, mentors and peers?

The biweekly deadlines, with feedback from teachers and industry representatives, are a large part of ongoing assessment. Additional opportunities for self-assessment probably also would work well.

22

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