Problem-Based Learning
Matters
PBLNetw
Collaborative Inquiry in Action

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The Problem-Based Learning Network at the Illinois Mathematics and Science Academy® serves teachers as they learn how to use the PBL model developed at IMSA. Opportunities include summer institutes and seminars to learn the model; classroom observations, consultations, and research to ensure positive effects in classrooms; and collaboration with other PBL practitioners through an interactive online network.

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# Problem-Based Learning Matters:
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## Acknowledgments

Professional development in problem-based learning at IMSA is grounded in the work of our former colleagues in their book:

What Is Problem-Based Learning?

Problem-based learning (PBL) is focused experiential learning organized around the investigation and resolution of messy, real-world problems.

- PBL engages students as stakeholders immersed in a messy, ill-structured, problematic situation.
- PBL organizes curriculum around this holistic problem, enabling student learning in relevant and connected ways.
- PBL creates a learning environment in which teachers coach student thinking and guide student inquiry, facilitating learning toward deeper levels of understanding while entering the inquiry as a co-investigator.

What Makes Problem-Based Learning Different?

**Curriculum as experience**
- fosters active learning
- supports knowledge construction
- integrates content areas
- provides relevance

**Learner as problem solver**
- defines problems and conditions for resolution
- establishes a context for learning
- pursues meaning and understanding
- becomes a self-directed learner

**Teacher as cognitive coach**
- models interest and enthusiasm for learning
- coaches student thinking
- exposes effective learning strategies
- nurtures an environment that supports open inquiry

**Problematic situation as organizing center**
- highlights a need for inquiry
- attracts and sustains student interest
- connects school learning and the real world
- enables meaningful learning

**Ill-structured problem as learning focus**
- displays messiness and complexity, reflecting the real world
- requires inquiry, information collection, and reflection
- emerges as changing and tentative
- creates multiple solution options
What Is the Impact of PBL on Learners?

Increases Motivation
PBL engages students in learning through the attraction or pull of problem dissonance or tension. They take on more and delve deeper as they make a personal investment in the outcome of their inquiry.

Makes Learning Relevant to the Real World
PBL offers students an obvious answer to their questions:

? "Why do we need to learn this information?"

? "What connection does school work have to the real world?"

Promotes Higher Order Thinking
Coupled with cognitive coaching strategies, the ill-structured problem scenario calls upon critical and creative thinking by suspending the guessing game of:

? “What's the answer that the teacher wants me to find?"

Students gather information significant to the problem and assess its credibility and validity. In bringing the problem to acceptable closure with evidence to support decisions, students meet high benchmarks of thinking.

Encourages Learning How to Learn
PBL promotes metacognition and self-regulated learning as students generate strategies for defining problems, gathering information, analyzing data, building and testing hypotheses, comparing strategies with those of other students and mentors, and sharing methods and conclusions.

Requires Authenticity
PBL engages student learning in ways that are similar to real world situations and assesses learning in ways that demonstrate understanding and not mere replication.

Why PBL in This Era of Standardized Testing?

Scientifically based research at a national level indicates that problem-based learning (PBL) is a superior methodology for promoting student engagement in the learning process. In December 2006, the New Commission on the Skills of the American Workforce issued a national report, *Tough Choices or Tough Times*, which includes recommendations for the future of education. Two key papers on pedagogy that support this report strongly advocate problem-based learning and professional development in PBL.

In one of these papers, James Pellegrino (2006) states,

The type of expertise advocated in the Commission Report goes well beyond the development of basic skills and ‘routine expertise’ and represents instead the levels of knowledge and understanding that can support transfer to new problems, creativity and innovation, something that we now recognize as ‘adaptive expertise.’ . . . Furthermore, given that teaching requires a unique form of expertise above and beyond knowledge of a given discipline, we must develop teachers who themselves have adaptive expertise in the domain of daily classroom instruction (pp. 1-2).

Pellegrino (2006) offers a powerful rationale for PBL’s emphasis on metacognition:

. . . a ‘metacognitive’ approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. . . . Teaching metacognitive strategies in context has been shown to improve understanding in physics, written composition, and heuristic methods of mathematical problem solving. And metacognitive practices have been shown to increase the degree to which students transfer to new settings and events” (p. 5).

In a second paper for *Tough Choices or Tough Times*, Karlyn Adams (2005) concludes with “Recommendations for Education” based on her meta-analysis of pertinent research:

1. **Design educational curricula that promote all three components of “successful intelligence”**: As Sternberg explains, today’s educational model generally supports the development of one kind of analytical thinking. This needs to be balanced with a focus on the synthetic, analytical and practical aspects of successful intelligence, especially as the combination of the three results in creativity. The use of divergent thinking exercises, open-ended challenges such as those posed by PBL programs . . . can all play a role in the development of the creative aspects of successful intelligence. (p. 50)

2. **Promote the decision to be creative and a meta-cognition of the creative process**: . . . This meta-cognition of the creative process should also involve explicit awareness of the practical skills involved in creativity such as the processes of managing one’s emotions, one’s ability to persevere in the face of challenge, the marshaling of cognitive resources, learning one’s strengths and weaknesses and managing time allocating to creative pursuits. (p. 50)

3. **Foster classroom environments and pedagogical approaches conducive to intrinsic motivation**: . . . Where appropriate, allow students to define their own problems and conduct a self-assessment of their efforts and outcomes, rather than always having work both defined and evaluated by teachers. (pp. 50-51)
4. **Increase the usage of problem and project based learning in the classroom:** Executed correctly, PBL programs have shown significant promise to increase a broad range of thinking abilities, including creative thinking and help link education to relevant, ill-defined, real-life experience. This connection is crucial for engaging students and increasing motivation, as well as helping develop the thinking skills crucial to “successful intelligence” as defined by Sternberg . . . (p. 51)

5. **Increase the use of interdisciplinary learning:** Lessons that span multiple subject areas will familiarize students with the concepts of linking otherwise separate concepts or disciplines to discover new ideas at the intersection of fields. Especially in the upper grades, having students work in teams where diverse talents, interests and thinking styles are represented will offer practice in the group dynamics that lead to organizational innovation (p. 51).

National/international test makers are also beginning to realize that there is more to education than the memorization of facts. An *Education Week* article (“U.S. Students Fare Poorly,” 2004) discusses the results of the Program for International Student Assessment, or PISA, which evaluates the academic competencies of 15-year-old students. Some key points include (bold added for emphasis):

In mathematics literacy, which measured students’ ability to make judgments about space and shape, change and relationships, quantity, and mathematical uncertainties, the U.S. score was 483, below the average score of 500 for industrialized nations. The United States ranked 24th out of 29 nations in that category (paragraph 4).

In problem-solving, “U.S. students earned an average combined score of 477, below the international average among industrialized countries of 500, also resulting in a ranking of 24th out of 29 nations” (paragraph 5).

“Unlike some tests, PISA seeks to assess skills that students have acquired both in and outside of school, and their ability to apply them in “real-world contexts,” according to officials at the National Center for Education Statistics, the U.S. government’s primary clearinghouse for education data (paragraph 10).

Problem-based learning provides a framework for students to engage in thinking critically, solving problems enhancing collaborative skills, and increasing content knowledge as they explore carefully crafted situations adapted from real world issues.

**Teachers recognize that they need specific professional development in PBL skills** in order to realize this powerful impact on their students. The Illinois State Board of Education recently conducted an online study (“Implications of Teacher Priorities,” 2005) of mathematics and science teachers to determine their professional development needs. Teachers at all experience levels gave high priority to professional development that a) provides a foundation for understanding the world, b) includes technology and reading instruction in mathematics and science, and c) addresses differentiation of instruction and motivation of a diverse student population. The ISBE study also states that “teachers increasingly understand that teaching is not a one-dimensional activity (e.g., transmission of knowledge through lectures) and that successful teaching of today’s students requires an array of strategies and skills. This is reflected in the survey results, which emphasize professional development focused on how to improve student performance and develop higher order skills such as critical thinking” (“Implications of Teacher Priorities,” 2005, p. 29).
IMSA’s professional development in PBL speaks to these needs with its focus on teaching educators how to design PBL classroom experiences that will incorporate authentic learning through solving a complex, real world problem. Students use technology to gather data and develop higher order thinking skills through reading, analyzing, and synthesizing scientific information. At the conclusion of a three-year professional development initiative in PBL, an external evaluator (Oyer, 2006) analyzed data from classroom observations, teacher surveys, and student surveys and concluded that “teachers consistently and effectively implemented all of the strategies promoted by the grant, in PBL units and throughout the curriculum” (p. 31). These strategies incorporate ways to differentiate instruction to meet the needs of all learners.

IMSA also collected data from the students of the teacher participants. 264 students from nine classrooms in seven schools completed a survey about a PBL unit from earlier in the year. Student responses provide strong evidence that the teachers incorporated constructivist strategies to a high degree. The median rating was 4.0 (based on a 5 point scale) for several survey items (Oyer, pp. 23-24):

- Students had a chance to think and talk about what they knew about the unit.
- The teacher used class charts to organize ideas.
- Ideas and activities helped students understand the issue.
- The pace of activities met students’ needs.
- Teachers gave students enough time to think before answering.
- Students had enough time and information to make sense of the problem.

Research conducted in collaboration with Northern Illinois University during IMSA’s Summer Sleuths program over two summers (Pierce & Gerdes, “Problem-based,” 2005, Pierce & Gerdes, “Self-directed,” 2005) affirms that PBL has a strong impact on these areas. Transcripts of student discussions show a significant increase in metacognitive statements initiated by students over the course of three days (Figure 1), with self-regulation of thinking evident in small group interactions independent of teacher facilitation (Pierce & Gerdes, “Self-directed,” 2005, p. 8).

![Figure 1: Number of Metacognitive Statements by Teachers and Students](chart)

**Students themselves recognized the value** of having opportunities to engage in group discussions and thinking processes such as research and critical thinking. More than 30% of the students (Pierce & Gerdes, “Self-directed,” 2005, p. 13) named those activities as the most helpful for understanding the problem that they were studying (Figure 2).
When asked in what activities they were most successful in the program (Pierce & Gerdes, “Self-directed,” 2005, p. 14), 51% of students’ responses involved thinking and research skills (Figure 3).

Parents also recognized the value of this summer PBL experience for their children. Typical comments on a survey at the end of the program show that parents noticed a difference in the learning climate and in their children’s motivation:

- Your program allows my son to experience "school" in a place and with a style of teaching that is much more creative and flexible than his public school education.
- By the end of the week I feel my child was very excited in sharing with me the results of the collective hard work he and his team did in the last four days. That, in itself, is rewarding to myself and my child.

With the volume of evidence from national research, teachers in the trenches, students and parents in overwhelming support of problem-based learning, it has become not only desirable but essential that the educational system transform itself to incorporate PBL as “the” pedagogical standard.
Why IMSA?

The Illinois Mathematics and Science Academy’s pioneering spirit cleared the way for problem-based learning in select courses. Students’, teachers’ and parents’ excitement for PBL attracted public attention and investor interest, leading to the establishment of IMSA’s Center for Problem-Based Learning in 1993. Since then, thousands of educators have participated in conference sessions, institutes and partnerships. They have grown professionally — building a knowledge base, developing skills and nurturing a disposition toward constructivist teaching and learning. Through newsletters and networking, their knowledge expands and their practice improves.

IMSA pioneered the development of a PBL model for K-12 educators and now has a worldwide reputation for PBL professional development. In 1992, IMSA began its external work in PBL through its inaugural Wingspread Conference, which many prominent educators attended and The Hitachi Foundation and The Johnson Foundation supported. The Problem-Based Learning Network (PBLN) has since provided extensive professional development in PBL to teachers in over 30 states and seven countries. An example of PBLN leadership includes 2003’s highly successful symposium, In the Service of Learning: Getting to the Heart of Problem-Based Learning, in which more than 200 educators from as far away as Mexico and Korea came together to learn about this powerful tool to enhance student learning in the classroom.

IMSA’s professional development in PBL results in teachers implementing constructivist skills in their classrooms. Teachers completed the external evaluator’s online CBAM (Concerns Based Adoption Model) survey and reported that they were implementing six key instructional strategies throughout the curriculum: employing higher order questions with reflection time, modeling and scaffolding questions for self-directed learners, challenging students to assess the relevance of their learning, responding to students’ Need to Know, and encouraging students to consider the implications of their conclusions (Oyer, 2006, p. 14). Teachers also took the opportunity to include their personal reflections on the overall impact of the initiative on their classrooms. All of their comments indicate that IMSA’s PBL professional development had a powerful impact on both them and their students:

- It has been a rewarding experience that has improved the learning and motivation of my students.
- My continued experience with PBL has impacted my teaching overall, even outside of PBL units. I have made an important shift in thinking that has been beneficial for my students’ learning and personal growth.
- These strategies have relevant use in all my teaching, not just PBL units, and I use them throughout.
- Having used PBL units for three years, I have incorporated many of the practices into my regular teaching regimen.
- I use these strategies at the beginning of units and also as a type of assessment to check for understanding of a new skill.
- My classroom is highly constructivist. The PBL experience has strengthened all areas of my teaching. It has been one of the most rewarding experiences of my 11-year teaching career.
- Using PBL units has informed and influenced nearly every facet of my teaching; I was student-centered before, but only in the most general sense. Now I am student-centered in a more specific and practical way.
Over the years, various publications have recognized and applauded IMSA’s PBL work, including *Teacher Magazine; Illinois Schools: Research and Development; Journal of Staff Development; Educational Leadership; Leadership News; The Wingspread Journal; Executive Educator;* and *Journal for the Education of the Gifted.*

**References**


What Makes PBL Effective?

Many formats for presenting and implementing problem-based learning units are possible; however, the following parameters remain consistent:

Educators present the problematic situation first, and it serves as the organizing center and context for learning.

The problematic situation has common characteristics:
- It is ill-structured and messy.
- It often changes with the addition of new information.
- It is not solved easily or with a specific formula.
- It does not result in one right answer.

Students are active problem-solvers and learners; teachers are cognitive and metacognitive coaches.

Learners share information but personally and individually construct knowledge. Discussion and challenge expose and test thinking.

Assessment is an authentic companion to the problem and process.

A PBL unit is not necessarily interdisciplinary, but it is always integrative.

What Might Engage Primary Learners in PBL?

**Kindergarten language arts:** Students and their teacher overhear another teacher remark that their classroom does not have many books. With their teacher, students analyze the problem and offer solutions for book collection, organization and care. (Students explore classifying, graphing, alphabetizing, and using library and group skills.)

**Kindergarten science:** The teacher coaches students to notice that invasive insects are eating the leaves off plants in the school’s garden, investigate and determine appropriate actions to rejuvenate the garden so that all plants are healthy and beneficial insects thrive. (Students learn simple food chains, plant structures and life cycles.)

**1st grade mathematics:** After a guest speaker from a local bank visits the class, a teacher coaches students to determine the need for a bank in their classroom. With the help of parent volunteers, students learn how to identify and describe the relative values and relationships among coins and solve addition and subtraction problems using currency.

**1st and 7th grade science:** The Department of Fish, Wildlife & Parks (DFW) asks students to choose one of its orphaned and injured animals and make recommendations about its proper placement. The 1st graders make recommendations that the 7th graders, as members of the Animal Rehabilitation Review Group for DFW, evaluate and either accept or reject. (1st graders study the animal’s special needs, habitats and diet.)

**Multi-age primary science:** Students are intrigued by a playground rumor of an alligator in the sewer. Could it be true, and what actions can they take if they find out it is?

**2nd grade science:** Students ask their principal to buy them a classroom pet. To convince the principal, the students must determine the appropriate pet for the environment, the costs involved with the care and maintenance of a pet, and the safety issues for all classroom members (including the pet).

**2nd grade science:** Students take on the role of advisors to NASA. A planet like Earth has experienced destruction of plant elements in its biosphere. What is causing the destruction? Can NASA successfully introduce plants from Earth to save the other planet’s environment?

**3rd grade social studies:** The school custodian asks students to resolve the problem of a loose dog on the school grounds in a way that is safe for both the students and dog and meets all local regulations. (Students study animal control regulations, pet adoption guidelines, and heath requirements for animals.)

**3rd grade social studies:** Students advise a local museum curator who wants to make the museum more attractive for students to come to learn about local history. What financial and educational issues must they consider, and what will draw students to the museum?
What Might Engage Intermediate Learners in PBL?

4th grade language arts: The students’ community wants to build a new convention complex along the river. City planners have received several letters of concern from environmentalists, community residents and developers. How can students meet the needs of all these groups?

4th grade science: A judge in Northern California issued a halt to all land sales and logging activity because of the endangered spotted owl population. The judge asks the class to develop a workable plan that will satisfy the various parties: the owls, trees, land developers, environmentalists and loggers.

4th grade science: The students are scientists in a rural Illinois county where the coyote population is increasing. What does that surge mean for the area? What threat do coyotes pose to residential areas? What are the implications for action at the local or state level?

4th grade social studies: The class receives a letter from a travel agent in another town. The letter asks the students to advise the tourist board on places of interest to 4th graders and their families traveling to the area. (Students explore the local highlights, costs and travel schedules.)

4th grade social studies: The students, as business development officers, determine whether a bank should open a branch in their school. (Students study how producers decide what goods and services to provide, factors that affect consumers’ choices and competition.)

4th-5th grade science: Students are stockholders of a major Louisiana oil refinery in the southern part of the state. Publicity about the potential destruction of the wetlands increases public pressure to turn the property over to the federal government. What actions should the stakeholders take?

5th grade health: The principal is concerned that students are not receiving proper nutrition because of the large amount of lunchroom waste. How can students advise the principal on lunch menus that will be nutritious and appealing to them?

5th grade mathematics: The district budget for after school sports does not include 5th grade. The students develop a presentation for the school board stating their concerns. (Student will research, collect and analyze data and conduct interviews.)

5th grade science: Students are members of a citizens’ group in the Fox Valley area who receive several letters from community members who are concerned with the appearance of the Fox River. How do they determine if there is a problem and, if so, what actions to take?

5th grade social studies: The students are English villagers whose king is preparing to send a ship to the New World to establish a colony. How does the village decide what skills are needed and what materials they need to take in order for this new colony to be a successful venture?
What Might Engage Middle School Learners in PBL?

**Language arts:** The principal asks the students to communicate information about their school to the community. (Students transfer mathematical statistics about demographics, resources and ratios to a written and visual mode and include interviews with staff, students and alumni in their final product.)

**Science:** Students are members of an evaluation committee for the Research and Development Team of a genetic engineering company. Product developers propose controlling the Canada Geese population through genetic engineering. What are the ethical, environmental and economic dimensions of this proposal?

**Science:** The students submit a proposal to NASA requesting that adolescent payload specialists join the space shuttle team to prepare for future human presence in space. What are the implications of this proposal?

**Science:** Minnesota students challenge Illinois students to investigate the possibility of frog deformities and declining populations of frogs in Illinois. What is happening? What are the human and environmental risks? How can students determine these risks?

**Science:** The students, as scientists with the State Department of Nuclear Safety, are confronted by residents of a small suburban community who feel that their health is at risk because a local company stores thorium waste above ground. What action, if any, should students take?

**Science:** The students are middle school children from a journalism school in New York. The borough president asks them to investigate solutions to the mysterious spread of the West Nile virus. What are the issues involving environmental safety, health risks, costs and infringements upon human activity?

**Science:** A state senator will soon vote on a bill “to limit genetic engineering to non-food items,” and asks students to research all perspectives of this issue and advise him/her how to vote.

**Science:** What factors should a dairy farmer consider while thinking about a GMO (genetically modified organism) partnership with a pharmaceutical company? (Students study genetics, ethics, farm economics, environmental impact/safety and community response.)

**Science and social studies:** The mayor asks students to investigate flooding in their community, taking into account zoning laws, aesthetics, economics, public opinion, safety, ecosystems, storm water management and the history of the area. How can they inform the mayor about ways to prevent future flooding problems?

**6th grade language arts:** An executive producer of a news department asks students to develop a pilot for a TV newsmagazine that reports all perspectives of a story in a truthful, responsible manner and at the same time attract viewers. (Students read *Nothing But the Truth* (Avi, 1991), interview local counterparts to the book’s characters, research responsible journalism and communicate with another class investigating the same problem in another school.)
6th grade mathematics: The principal asks the students, who are sharing lockers, to calculate how much storage space a typical student needs, because the school is going to purchase new lockers. How many and what kind of lockers should the school purchase, given its budget. (Students study geometric concepts of volume and surface area, costs, aesthetics and alternative storage approaches.)

6th grade mathematics: The president of a dairy company asks students to design a new milk carton that is both appealing to the consumer and practical for shipping and displays. (The students explore volume, surface area, perimeter and circumference.)

6th grade social studies: The students are advisors to a state representative on a bill to regulate livestock waste management just as a company proposes a “mega” hog farm for the county. What environmental, economic, political and societal consequences should they consider?

1st and 7th grade science: The Department of Fish, Wildlife & Parks asks students to make recommendations about the proper placement of orphaned and injured animals. 1st graders make recommendations that the 7th graders, as members of the Animal Rehabilitation Review Group, evaluate. (7th graders research rehab/release methods, graph success rates, and locate and contact primary sources.)

7th/8th grade mathematics: The business office investigates ways to conserve energy use in schools. The principal appeals to mathematics classes to analyze current and future energy usage and make recommendations. (Students study alternative energy sources, complete cost/benefit analyses, and create and interpret graphs to substantiate their findings.)

7th grade physics: Students are members of a Park Advisory Committee. The police department is tired of warning and disciplining skateboarders violating the city ordinance, and asks students for advice about creating a safe, non-invasive place for skateboarders and roller bladers within the community. What are the issues involved?

7th grade life science: Students studying ecology receive a letter from the Illinois Farm Bureau that discusses the overpopulation of deer and the increase in related traffic accidents and fatalities. The students consider the situation and offer possible solutions. (Students explore habitat, hunting regulations, diseases caused by overcrowding, and methods of population reduction.)

8th grade science: Concerned parents lobby the school board to replace fluorescent lights with incandescent lights because they believe that fluorescent lighting harms students’ eyesight. The principal asks students to investigate the science behind the claim. (Students study different types of light, the electromagnetic spectrum, Calculator Based Laboratory system and light meters, and spectroscopy.)
What Might Engage High School Learners in PBL?

**Algebra:** A local man wins a large amount of money in the lottery and asks for advice on how to invest his winnings wisely. (Students explore the concept of investing and learn investment terms. They contact local tax advisors, investment advisors and financial institutions to understand how the financial industry works.)

**Alternative high school:** A school site that has been unoccupied for the past seven years is now reopening. How can the school improve the run-down appearance of the grounds but stay within budget?

**American literature:** The students are members of the Alabama Historical Society which a family has contracted to research their background during the time period of the novel *To Kill a Mockingbird*. What happened? How reliable is the information? Who needs to know—or not?

**American literature:** A member of a local citizens’ group challenges the inclusion of Mark Twain’s novel *The Adventures of Huckleberry Finn* in the curriculum. What are the issues? Should students study this novel? Why or why not?

**American studies:** Students are southwest field agents for the Centers for Disease Control (CDC), which has to prepare a press release concerning plague patterns, conditions and precautions based on data from the past ten years. What are the facts, who is the public, and how does the CDC communicate effectively with them?

**AP biology:** The Community Health Department asks students to develop a strategic plan to contain an infectious disease within their high school and also to educate the school population on correct protocols to avoid mass hysteria. (Students study the dynamics of an infectious disease and collect, evaluate and use data, graphing and charting.)

**Basic level biology:** The school has procured land to develop athletic fields. Students are resource managers for an impact study to determine the current ecosystem and possible impact on it.

**Biology:** Due to the low population density of the area, a nearby community has been selected to receive a federal government P4 containment lab. Citizens seek advice from the students regarding what would happen if the germs somehow escaped from the lab. Authorities would not say exactly what the lab would hold but hinted at any one of the following pathogens: anthrax, Clostridium botulinum, or other pathogens (selected by the teacher to meet curriculum needs).

**Biology:** An entertainment company wants to purchase extensive acreage in a forest preserve in the southwest suburbs of Chicago in order to build a new football stadium, practice facility and theme park. What environmental, economic and traffic issues does the community need to consider?

**Biology:** Students are experts on a particular endangered animal and create a zoo habitat to meet the animal’s needs.
**Earth science**: The state, in cooperation with the Army Corps of Engineers, asks Earth science students to investigate flooding and its impact on the current system of levees along the Mississippi River. The students advise these governmental agencies on what improvements, if any, are needed to the current levee system. (Students explore the impact of flooding in the river basin and possible solutions to reduce its impact.)

**Ecology**: Students, as members of the committee on the Environment and Natural Resources, are reviewing Minnesota House Bill #1891, which lays out a gray wolf management plan for the state. Should the bill pass? What are the consequences of its passage or defeat?

**Geometry**: The current high school building is under construction for additional space and renovation. Students will prepare a proposal for the administration with recommendations and substantiation of their choices as they consider the variables of various desk/chair designs, including size, cost, effective use of workspace, comfort in design, and color.

**Math/Physics**: A pre-school institution that wants to investigate the effects of music on child behavior approaches student researchers on music therapy. The institution is interested in how music therapy can improve children’s motor and communication skills. As researchers, students consult:

1. a physicist to understand how music is generated,
2. a mathematician to understand the characteristics of sound waves, and
3. a behavioral scientist to determine how consonance, dissonance and changes in pitch and volume affect child behavior.

**World history**: Student spies for the Hun/Barbarian leaders gather information about the Roman Empire as a basis for an attack plan.

**9th grade science**: Students are investigators from the Environmental Protection Agency, which is investigating the conditions that may be responsible for the high cancer rates in Livingston County, Illinois. (Students will explore sources of carcinogens, geological and environmental aspects of the county, and the nature of cancer.)

**12th grade fine arts**: The Art League has asked fine arts students to design a logo and a brand for the upcoming community art show. (Students incorporate the principles of good design with the basics of marketing strategies as they consider the medium and costs of the promotion.)
What Might Engage Adult Learners in PBL?

**Administrators:** The principal challenges the staff to develop a unified school-wide assessment plan that meets a goal in the School Improvement Plan. The assessment tool should seamlessly link to the curriculum, reflect the district’s philosophy of education, be user friendly, communicate students’ strengths and weaknesses, and be transferable to other educational institutions.

**Administrators and teachers** would like to enrich the Shakespeare Festival for younger students in an age-appropriate manner. They want to present Shakespeare so that the students will be able to identify important characters’ qualities and motivations; literary elements (themes, plots, settings, etc.); and historical content and reflect on their experiences.

**The director of development** has sensed tension between the CLS (Classroom Solution Center) and the program area. He asks a special task force to investigate how the CLS can partner with the program area to develop training that provides participants with skills relevant to stated objectives; maintains design integrity; adheres to budget/time constraints; provokes creativity, thought, leadership and motivation; and is a collaborative output of CLS and the program area.

**The director of elementary learning** asks a representative group of teachers to select a new social science textbook series. The new series should address several issues, including meeting divergent student needs, reflecting state standards and fitting within the district’s budgetary guidelines.

**Education majors in college** are members of an interdisciplinary teaching team responsible for explaining the school’s change from the junior high concept to a middle school concept. How do they alleviate parents’ concerns about this change?

**The legislative board for an academy** is considering a mandatory genetic profile of all students. They ask school administrators to make recommendations, considering ethical, political, moral and personal issues.

**Members of a citizens’ advisory group** are considering mosquito abatement practices in the county. Political, economic and health concerns conflict. What actions should or should not occur? What consequences attend each decision?

**Members of a Kentucky congressional candidate’s advisory committee** are to develop a platform statement on tobacco. Kentucky shares a proud tobacco-growing heritage, but recent disclosures highlight complex issues affecting not only constituents, but the nation as well. What policy statement will best address the issues fairly, accurately and ethically?

**The staff of a middle school** has received a federal grant to integrate technology into the curriculum via real-world, community issues. What are the opportunities and the obstacles?
How Does PBL Relate to Best Practices?

**Principles of Learning**

- Learning is not necessarily an outcome of teaching.
- Students’ existing knowledge base influences their learning.
- Learning usually progresses from the concrete to the abstract.
- People learn most effectively through practice.
- Effective learning requires feedback.
- Expectations affect performance.

**Principles of Teaching**

- Teaching should be consistent with the nature of inquiry.
  - Start with questions.
  - Engage students actively.
  - Concentrate on the collection and use of evidence.
  - Provide historical perspectives.
  - Insist on clear expression.
  - Use a team approach.
  - Do not separate knowing from finding out.
  - De-emphasize the memorization of technical vocabulary.

- Science teaching should reflect scientific values.
  - Welcome curiosity.
  - Reward creativity.
  - Encourage healthy questioning.
  - Avoid dogmatism.
  - Promote aesthetic responses.

- All teaching should aim to counteract learning anxieties.
  - Build on success.
  - Provide abundant experience in using tools.
  - Support the roles of girls and minorities in science and mathematics.
  - Emphasize group learning.

- Science teaching should extend beyond the school.

- Teaching should take its time.

### How Does PBL Relate to Constructivism?


As Brooks and Brooks (1993) state in the first edition of their book, “Constructivism is not a theory about teaching. It’s a theory about knowledge and learning” (p. vii).

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| “. . . for students, schooling must be a time of curiosity, exploration, and inquiry, and memorizing information must be subordinated to learning how to find information to solve real problems” (p. 9). | “In this book you will read about the following five overarching principles evident in constructivist classrooms:  
- Teachers seek and value their students’ points of view.  
- Classroom activities challenge students’ suppositions.  
- Teachers pose problems of emerging relevance.  
- Teachers build lessons around primary concepts and “big” ideas.  
- Teachers assess student learning in the context of daily teaching” (pp. ix-x). |
| “Deep understanding occurs when the presence of new information prompts the emergence or enhancement of cognitive structures that enable us to rethink our prior ideas” (p. 15). | “Helping students or groups of students to clarify for themselves the nature of their own questions, to pose their questions in terms they can pursue, and to interpret the results in light of other knowledge they have generated is the teacher’s main task” (p. 30). |
| “Engagement in meaningful work, initiated and mediated by skillful teachers, is the only high road to real thinking and learning” (p. x). | “Educators must invite students to experience the world’s richness, empower them to ask their own questions and seek their own answers, and challenge them to understand the world’s complexities” (p. 5). |

“To understand constructivism, educators must focus attention on the learner” (p. 22).

“When teachers recognize and honor the human impulse to construct new understandings, unlimited possibilities are created for students” (p. 21).
How Does PBL Relate to Science Literacy?

In today’s world, adult literacy has come to include knowledge and competencies associated with science, mathematics, and technology. Project 2061 has undertaken to identify the knowledge and habits of mind that people need if they are to live interesting, responsible, and productive lives in a culture in which science, mathematics, and technology are central -- that is, to describe what constitutes the substance of science literacy.

People who are literate in science are not necessarily able to do science, mathematics, or engineering in a professional sense, any more than a music-literate person needs [to] be able to compose music or play an instrument. Such people are able, however, to use the habits of mind and knowledge of science, mathematics, and technology they have acquired to think about and make sense of many of the ideas, claims, and events that they encounter in everyday life.


Science Literacy Habits of Mind Foster the Following Abilities:

A. the capacity to formulate questions; seek, comprehend and use available information; gather and interpret data; and draw logical inferences in relation to an area of investigation;

B. the ability to comprehend and communicate the language, concepts, theories and practices of science, mathematics and technology in ways that promote mutual understanding, cooperative problem solving and shared vision;

C. the awareness that science, mathematics and technology are ongoing processes and growing disciplines, constantly evolving and being refined through inquiry and open-ended investigation;

D. the awareness that science, mathematics and technology are interdependent and that the tools and methods of each are interrelated and mutually supportive; and

E. the understanding that science, mathematics and technology have strengths and limitations, in both theory and application, particularly as they relate to societal and ethical issues.

How Does PBL Relate to 21st Century Skills?

In 2003 the North Central Regional Educational Laboratory and the Metiri Group identified learning skills essential for students to thrive in the 21st century and developed criteria to gauge progress in those skills.

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<td>• Scientific Literacy</td>
<td>• Self-Direction</td>
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<td>• Multicultural Literacy</td>
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<td>• Global Awareness</td>
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<th>Effective Communication</th>
<th>High Productivity</th>
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<td>• Teaming and Collaboration</td>
<td>• Prioritizing, Planning and Managing for Results</td>
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<td>• Interpersonal Skills</td>
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<td>• Personal Responsibility</td>
<td>• Ability to Produce Relevant, High-Quality Products</td>
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<td>• Social and Civic Responsibility</td>
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<td>• Interactive Communication</td>
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Who Is Working Online in PBL?

The Problem-Based Learning Network, Illinois Mathematics and Science Academy
www.imsa.edu/programs/pbln

The Interdisciplinary Journal of Problem-based Learning (IJPBL), Purdue University
http://docs.lib.purdue.edu/IJPBL/ is a quarterly online periodical on both the theory and practice of PBL. This scholarly journal engages researchers and practitioners in meaningful conversations about PBL. Its goal is to publish relevant, interesting and challenging articles of research and analysis related to all aspects of implementing PBL.

McMaster University, Canada
http://www.chemeng.mcmaster.ca/pbl/pbl.htm has been a world leader in the development and use of problem-based learning. The link “Problem-based Learning, Especially in the Context of Large Classes” offers suggestions for small-group, self-directed PBL. The site also recommends and extensively reviews books to help both students and teachers.

University of Delaware
http://www.udel.edu/pbl/ maintains a Web site with current PBL articles and books. Sample PBL problems and “Groups in Action” videos bring PBL to life. The site links to the Pan-American Network and other PBL conferences.

Samford University, Alabama
http://www.samford.edu/ctls/pbl provides administrators, faculty, students and parents with information on the components, implementation, assessment and documentation of PBL. There is a guide to relevant workshops, conferences and materials and also links to other institutions that use PBL in undergraduate and/or graduate programs.

The Center for Educational Development at Republic Polytechnic, Singapore
http://myrp.sg/ced maintains a PBL Web site for students, facilitators, and developers of PBL. The site contains research and links to PBL-related literature, general education sites, discipline-specific Issues, and the Center’s newsletter. The site also links to CED staff papers presented at international conferences and/or published in educational journals and books.

Central Queensland University, Australia
http://pbl.cqu.edu.au/index.html supports students, coaches and course developers of PBL. The Web page includes an e-newsletter, an e-board for questions and discussions, and a separate FAQ section. The online resources link includes PBL examples, literature and role-playing simulations.

Edutopia, The George Lucas Educational Foundation
http://www.edutopia.org/ is a multi-media resource for constructivist teachers that documents, disseminates and supports exemplary public school K-12 programs.
Who Is Writing About PBL?


