Table of Contents
Designing Effective Projects Adaptation for Essentials Course v.10

Project Design

Designing Effective Projects: Curriculum-Framing Questions
Transforming the Classroom with Effective Questioning Practices

Strategies for Engaging All Learners

Incorporating Essential and Unit Questions into the curriculum is an effective way to promote student inquiry and target higher-order thinking, but it takes more than a few good questions to truly transform a classroom and engage all students in learning.

Research and development specialists, Jackie Walsh and Beth Sattes (2005), authors of *Quality Questioning: Research-Based Practice to Engage Every Learner*, claim that knowing how to formulate quality questions is only the first step in the process of transforming classrooms. They argue that if educators wish to engage all students in answering the questions, they must also teach new questioning behaviors to students and adopt classroom norms that support them.

To begin the process of transforming your classroom, establish a risk-free setting where students feel comfortable asking and answering questions. Make sure that everyone understands that no question is a bad question, and always allow plenty of time for students to formulate, process, and answer the questions.

Next, assign projects that require students to answer the “big questions” and back them up with evidence. Present students with scenarios or problems where they must derive the solutions themselves. In the beginning, students that are unfamiliar with open-ended questioning, most likely will need guidance as well as assurance that there may be many right answers. Provide students with appropriate scaffolds that will ensure success and frequently monitor their work. Remind students to provide rationale for their opinions and to formulate hypotheses, based on facts.

Make time for questions. Use probing techniques to urge students to clarify their ideas and explain their reasoning. Then, challenge them with even more complex questions. Help students to understand that in order to answer the big questions, they may need to address the smaller questions first.

Once students are accustomed to exploring and answering open-ended questions supported by evidence, take a step back and assume the role of facilitator. Teach students how to generate their own questions and encourage them to elaborate and build on each other's ideas.

Finally, as you begin to assess student work, consider the effectiveness of your own questioning practices. If students are unable to adequately answer the Essential and Unit Questions and support their answers with evidence, is it because you need to modify the questions? Do you need to utilize more effective probing techniques to urge students to clarify their ideas and explain their reasoning? Or do you need to provide more scaffolds to ensure objectives are met? If all students are not engaged in the learning, do you need to reinforce classroom practices so that all students feel free to share their ideas or state their opinions? If student work does not demonstrate higher-order thinking and include unique responses or creative approaches, do you need to modify your project requirements or assessment tools to target these skills? Or do you need to provide more practice and guidance in how to address open-ended questions?

Transforming your classroom into a place where all students are engaged and interested in asking and answering the big questions will require time and work, and monitoring and adjusting, but the rewards of students engaged in thinking and learning are worth the effort.

Resources

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Thinking Skills

Designing Effective Projects: Thinking Skills Frameworks
Learning Styles

Differences in Learning

Today's teacher knows that the ways in which students learn vary greatly. Individual students have particular strengths and weaknesses which can be built upon and enhanced through effective instruction. Project-based learning with technology is a powerful way to use students' strengths to help them become better thinkers and more independent learners.

Project tasks that allow students to use their individual learning styles are not a direct path to higher-order thinking, however. It is possible to create products that reflect shallow and superficial thought. (Ennis, 2000). Nevertheless, the motivating factors associated with choice when individual learning styles are addressed in projects, suggest that teaching thinking skills in the context of individual learning styles increases the likelihood that students will learn them.

The use of technology in projects also provides opportunities for students to make choices about how they learn, allowing them to take advantage of the strengths of their learning styles. Using software and hardware to create videos, slideshows, publications, and musical compositions can help students learn thinking skills and subject matter content in ways that acknowledge their talents and interests.

Visual-Auditory-Kinesthetic Learning Styles

The simplest and most common way of identifying different learning styles is based on the senses. Commonly called the VAK model, this framework describes learners as visual, auditory, or kinesthetic. Visual learners most effectively process visual information; auditory learners understand best through hearing; and kinesthetic/tactile learners learn through touch and movement. A study conducted by Specific Diagnostic Studies found that 29 percent of all students in elementary and secondary schools are visual learners, 34 percent learn through auditory means, and 37 percent learn best through kinesthetic/tactile modes (Miller, 2001).

VAK Learning Styles

Visual	Pictures, videos, graphics, diagrams, charts, models
Auditory	Lecture, recording, storytelling, music, verbalization, questioning
Kinesthetic	Acting, role-play, clay modeling

Many online inventories and questionnaires are available to help people determine their preferred learning style. Although most are not scientifically reliable, they provide insight into learning preferences. Teachers must exercise caution, however, in relying on students' self-assessment of their learning styles. Researchers Barbe, Milone, and Swassing (cited in Cotton, 1998) argue that learners' preferences are not necessarily the area in which they are the strongest. In addition, all learning styles are not necessarily appropriate for all content. While it may be possible to learn something about driving a car by watching or hearing someone discuss it, few of us would want to be on the road with people who haven't had considerable hands-on learning experiences in an automobile. Choosing teaching methods based on sensory learning styles requires deep subject matter knowledge and good teacher judgment.

Left-Brain/Right Brain Learning Differences

Another method of categorizing individual learning styles is by brain hemispheres. Asselin and Mooney (cited in Miller, 2001) described learners as either right brain, global, or left brain, analytic. In general, global learners "perceive things as a whole, make broad general distinctions among concepts, are people oriented, and learn material in a social context" (p. 3). Analytic learners, on the other hand, perceive things in parts rather than as whole and impose structure or restrictions on information and concepts" (Miller, 2001, p. 3).

> How individuals concentrate on and remember new and difficult information is related to whether their cognitive processing style is global or analytic. Some students learn more easily when information is presented step-by-step in a sequential pattern that builds toward a conceptual understanding. Others learn more easily either when they understand the concept first and then concentrate on the details or when they are introduced to the information with a humorous story or anecdote related to their experience and replete with examples and graphics (Dunn, 1995, p. 18).

Brain Hemispheres

Left Brain:	Analytical, logical, sequential, step-by-step, rational, part-to-whole
Right Brain:	Holistic, random, intuitive, subjective, synthesizing

Howard Gardner's Multiple Intelligences

In the last decade, more and more educators have warmed to Howard Gardner's theory of Multiple Intelligences. Logical/mathematical and linguistic intelligences, the two ways of thinking most valued in school are only two of eight intelligences described by Gardner based on biological and cultural research. In addition, he found spatial, musical, bodily/kinesthetic, interpersonal, intrapersonal, and naturalist intelligences.

Multiple Intelligences

Logical-Mathematical	The ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.
Linguistic	Mastery of language. This intelligence includes the ability to effectively manipulate language to express oneself rhetorically or poetically. It also allows one to use language as a means to remember information.
Spatial	The ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains.
Musical	The capability to recognize and compose musical pitches, tones, and rhythms.
Bodily-Kinesthetic	The ability to use one's mental abilities to coordinate one's own bodily movements. This intelligence challenges the popular belief that mental and physical activity are unrelated (ERIC, 1996, p. 2).
Interpersonal	A core capacity to notice distinctions among others; in particular contrasts in their moods, temperaments, motivations, and intentions (Gardner, 1993, p. 42).
Intrapersonal	Access to one's own feeling life, one's range of emotions, the capacity to effect discriminations among these emotions and eventually to label them and to draw upon them as a means of understanding and guiding one's own behavior (p. 44).
Naturalist	Expertise in the recognition and classification of plants and animals. These same skills of observing, collecting, and categorizing might also be applied in the "human" environment. (Campbell, 2003, p. 84).

Learning Styles and Thinking Skills

A student who relies on hunches, feelings, and intuition to make decisions may have difficulty recognizing the value of a thinking process that prizes the careful analysis of assumptions and weighing of evidence. On the other hand, a student who is comfortable with linear thinking and the rational dissection of arguments, may find global, connected thinking extremely challenging. In any case, individuals can exhibit different learning and thinking styles in different contexts, and adding on a new credible way of processing information can only enhance a person's ability to make smart decisions in life. In order to help all students become the best thinkers they can be, may require not only expanding our ideas of what good thinking is, but also finding ways to persuade students of the value of using thinking strategies that may, at first, feel strange and uncomfortable.

In the Classroom: Learning Styles at Work

Elementary Concept: Simple Machines

VAK	Visual	Look for pictures of simple machines in newspapers or movies
	Auditory	Listen to and watch a construction worker explain how he or she uses simple machines at work
	Kinesthetic	Build a simple machine from clay
Left Brain/ Right Brain	Left Brain	Follow step-by-step directions to build a simple machine
	Right Brain	Discuss the role that machines play in our lives
Multiple Intelligences	Logical-Mathematical	Break complex machines down into simple machines
	Linguistic	Write a paper or make a speech describing the importance of a machine
	Spatial	Create a presentation showing the different ways in which a simple machine is used.
	Musical	Compose a song about a simple machine that uses the appropriate vocabulary.
	Bodily-Kinesthetic	Use everyday objects to create a simple machine
	Interpersonal	Work with a group to make a video about simple machines for pre-school children
	Intrapersonal	Keep a journal reflecting on how your learning about simple machines is progressing
	Naturalist	Find examples of simple machines in nature, such as birds' beaks as levers

Secondary Concept: Interpretations of Allegories in Literature

VAK	Visual	Watch one of the *Lord of the Rings* movies and interpret it as an allegory
	Auditory	Listen to a sermon on parables or allegories from a religious perspective
	Kinesthetic	Make a video of an allegory
Personality Types	Introvert	Find an allegory that is especially meaningful to you and write a paper explaining its meaning.
	Extravert	Participate in a discussion of the allegory in *Lord of the Flies*
	Sensing	Compose an allegory based on something you have observed in your school
	Intuitive	Look at allegories from different cultures and identify patterns
	Thinking	Apply the components of an allegory to specifics of daily life
	Feeling	Write an allegory addressing an aspect of human experience that affects people's happiness
	Judging	Write a detailed project plan for developing an animated allegory
	Perceiving	Generate a list of possible projects related to allegories and select one to work on in more detail
Multiple Intelligences	Logical-Mathematical	Interpret an allegory and discuss the consequences of its assumptions in a different context
	Linguistic	Write an original allegory

	Spatial	Make a model that represents an allegory
	Musical	Analyze the allegorical components of Don McLean's song, *American Pie*
	Bodily-Kinesthetic	Perform an allegory
	Interpersonal	Work with a group to produce a multimedia presentation about an allegory
	Intrapersonal	Apply the meaning of an allegory to your own life
	Naturalist	Write an allegory inspired by the behavior of animals in the wild

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Designing Effective Projects: Analysis
Critical Thinking

Searching for the Truth

When educators discuss helping students develop their thinking skills, they often refer to critical thinking as their goal. This term which is used frequently in educational circles generally means forming opinions by seeking out relevant information, thoughtfully and objectively evaluating the quality of the information, and changing our minds when new credible information comes to our attention.

Critical thinkers are always asking "Why?" or "How?" and are always on the lookout for relevant information. In addition to the ability to analyze and evaluate what they find out, critical thinkers also exhibit an inquisitive open-mindedness that drives them to seek the truth and the flexibility to change their minds when confronted with good reasons to do so.

The most persuasive argument for the teaching of critical thinking, however, is a picture of what the world looks like when people do not think critically. A non-critical way of looking at the world around us consists of blind acceptance of advertising, political statements, textbooks, print resources, and the positions of organizations and institutions (Messina and Messina 2005). Although critical thinking is often thought of as negative, as in the refusal to believe what is false, it also refers to the acceptance of what is true. Refusing to believe anything is no better than believing everything.

Cognitive Skills

In 1990, a group of experts on critical thinking put together the *Delphi Report* which examined the

concept of critical thinking and made recommendations for teaching it. Read more about their conclusions in the Executive Summary*. (PDF; 20 pages)

The report lists the following skills and sub-skills involved in critical thinking:

Interpretation
- Categorization
- Decoding Significance
- Clarifying Meaning

Analysis
- Examining Ideas
- Identifying Arguments
- Analyzing Arguments

Evaluation
- Assessing Claims
- Assessing Arguments

Inference
- Querying Evidence
- Conjecturing Alternatives
- Drawing Conclusions

Explanation
- Stating Results
- Justifying Procedures
- Presenting Arguments

Self-Regulation
- Self-examination
- Self-correction

Teaching Critical Thinking in Grade 6

In the Unit Plan, Don't Trash the Earth, sixth graders exercise their critical-thinking abilities to make decisions about the environment. Their task is to evaluate the school's recycling and waste management practices. After analyzing current methods, teams develop a new recycling plan complete with cost analysis and supporting data, and present their proposals to the principal. In a final show of social responsibility, student entrepreneurs turn trash into treasure as they divert materials from the waste stream and turn it into attractive merchandise they sell at a holiday business fair.

To complete this project successfully, the students interpret the information they hear and read about recycling and waste management. They categorize the different methods of recycling to find those that are appropriate for their specific situation. They also decide which information is important to consider, and they get clarification for terms and concepts they do not understand.

As the students listen to speakers and find information in print and online resources, they analyze what they have found. They think about the arguments made for different types of recycling and think about their claims, the evidence that supports them, and the conclusions they draw. Based on what they see in the arguments, the students evaluate their resources, making judgments about which claims are reasonable, which evidence is credible, and which conclusions are logical. See the *Showing Evidence Tool* for a way to have students think about evaluating arguments and points of view.

As students become familiar with the content related to recycling and waste management, they exercise their inference skills by combining the knowledge they have acquired with their personal experiences to ask questions about the evidence they are reading. They also think creatively by putting what they know together and drawing conclusions about the consequences of the use of

particular methods in their school. They can also develop new alternatives based on what they have learned.

Finally, students communicate their conclusions in a presentation to the principal. For this presentation, they explain the sources of their information and why they made the decisions they made.

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Designing Effective Project: Using Knowledge
Problem Solving

Creating Solutions

Problem solving takes place whenever we are confronted with a barrier or challenge to achieving a goal. Problems can be simply solved, such as sharpening a pencil when the tip breaks, or can take years and input from hundreds of experts, such as coming up with a solution to global warming. Problems can have social, cultural, political, and personal dimensions. Some problems may have dozens of good solutions, and some may have only a few poor solutions. What is a serious problem for one person may not be a problem at all for another. In all cases, solving problems is part of learning and part of life.

Knowledge is extremely important for solving problems, because information is the fuel that leads us to success. Anyone can relate to being stuck with a problem, such as a plugged up sink, a screaming child, or a stalled car, knowing that the problem is solvable, but just not having the information needed to solve it.

Facione (1999) describes a list of characteristics of good problem solvers developed by experts in critical thinking. These people show

- Clarity in stating the question or concern
- Orderliness in working with complexity
- Diligence in seeking relevant information
- Reasonableness in selecting and applying criteria
- Care in focusing attention on the concern at hand
- Persistence through difficulties are encountered
- Precision to the degree permitted by the subject and the circumstances

Wilson, Fernandez, and Hadaway (1993) add that those who are proficient at mathematical problem solving are aware of a variety of processes that they can use and also have the ability to invent new strategies when they encounter unexpected situations.

Problem Solving Processes

Problem solving begins with the identification of a problem. Specifying and describing a problem may be more of a creative process than an analytical one, since this stage requires the ability to see how things could be different. For example, Teri Pall, who invented the cordless phone in 1965, thought that it would be possible to talk on the phone while moving about the house. This took as much imagination as it did technical know-how.

Cognitive processes are also important in problem solving. Anderson and his colleagues (1999) explain how different thinking skills contribute to the resolution of a problem.

- *Comprehension* helps learners make a visual representation of the problem.
- *Remembering* helps people call up the information and procedures they will need.
- *Synthesis* helps them organize the knowledge they have gathered into a structure that will be most useful and efficient.
- *Evaluation* is used to decide which methods to use and whether these methods have worked.
- *Metacognitive strategies* help problem solvers set goals, make plans, change strategies in mid-stream if they need to, and make decisions about the success of the solution.

Technology and Problem Solving

The use of computer technology as a tool in problem solving has become more widespread as computers have become more sophisticated and available. A variety of types of software help users portray problems graphically. Computer-based communication can provide learners with access to the information they need to produce solutions. It can also place students in contact with experts who can offer them strategies and encouragement.

Some kinds of computer games can provide students practice at understanding a problem, finding and organizing necessary information, developing a plan of action, "reasoning, hypothesis-testing and decision making," and building awareness of different kinds of problem-solving tools (Wegerif, 2002, p. 28).

Wegerif (2002) eloquently describes the role that technology can play in solving problems:

Before the arrival of computers in human history it seemed natural to many to describe 'higher order thinking', or rationality, in terms of abstract reason on the model of formal logic or mathematics. This kind of thinking was really hard, potentially very useful and only a few people could do it well. Computers, however, find formal reasoning very easy. What they find hard is the sort of things most people take for granted like coming up creatively with new ways forward in complex, fast-changing and open-ended contexts where there is no certainty of being right. One way in which thinking skills are related to developments in technology is therefore simply that the human skills that we value most, and that are rewarded the most, are those skills that computers cannot yet imitate.

Teaching Problem Solving

In order for students to develop into expert problem solvers, they must first encounter problems that engage them and give them opportunities to develop the skills they need to learn. Through project-based learning, students have direct experience solving problems.

The types of problems that benefit students the most are the ones that perplex them. For a problem to have the most benefit for students it must be challenging enough to require the regulation of cognitive and metacognitive strategies.

One way in which teachers can improve students' problem-solving skills is by having them focus on processes rather than outcomes. Dr. Ellen Langer, psychology professor, points out that thinking of outcomes often inhibits students in problem solving. A process orientation, thinking "How do I do it?" instead of "Can I do it?" helps them think actively of different ways in which a problem might be solved instead of focusing on the many possibilities for failure (Langer, 1989, p. 34).

A group of researchers in math education emphasize the importance of reflection during problem-solving activities. "It is what you learn after you have solved the problem that really counts," they explain (Wilson, Fernandez, & Hadaway, 1993). However, they warn that developing the desire to look back in students is very difficult. This is due, in part, to the specific culture of many mathematics classrooms in which the purpose of solving a problem is just to find the answer, not to learn problem-solving skills.

Reflection can occur in classrooms in both formal and informal ways. Providing time just for writing or talking about the processes they used to solve problems can help students refine their own processes. There is also considerable research to support the notion that students improve their problem-solving skills by working in groups (Wegerif, 2002). These social situations provide them with natural ways of discussing how work on a project is progressing.

It is tempting to provide students with a heuristic, or a rule of thumb, when solving problems. For many teachers and students alike, a left-brain process like following a series of steps when confronting a challenge seems like a logical way to approach a problem. Teachers must bear in mind, however, the many ways in which students' thinking and learning styles differ. There is considerable evidence that the right brain plays a significant role in solving problems by imagining alternatives, viewing the whole picture, and assigning value to alternative solutions.

Huitt (1998) suggests that, along with the critical and evaluative processes that are so important in problem solving, there is a second group of skills that "tended to be more holistic and parallel, more emotional and intuitive, more creative, more visual, and more tactual/kinesthetic." He argues that successful problem solvers are creative as well as logical. Both ways of thinking are critical to success. In fact, creativity is often thought to be a special kind of problem solving process.

There are few skills as important for students to learn as problem-solving skills. Young people who can identify problems that can be solved, explore options for solutions, use appropriate thinking strategies, and manage the whole process metacognitively, are equipped for success in school, in the workplace, and in life.

Examples of Problem Solving

Problem solving is such a critical skill that it is difficult to imagine an authentic situation in which students would not be practicing it. Settling disputes on the playground, working through a disagreement with a friend, arguing with a teacher over a grade or with parents over a curfew, are the kinds of problems students must solve in their everyday life. In any kind of complex activity or project, there are also countless problems to be addressed, such as issues with technology, irresponsible group members, inadequate materials, and so forth.

Some projects, however, are built around the solving of big, important problems, often connected in some way to the community. In the Unit Plan, Go-Go Gadget: Invent a Machine, students identify work they want to perform, and invent a labor-saving machine to do the job. To help students improve their problem-solving skills during this unit, a teacher could offer mini-lessons on brainstorming, using drawing software to represent a problem, or modeling how to explain thinking processes to others.

In the Unit Plan, Don't Trash the Earth, middle school students turn trash into treasure as they divert materials from the waste stream and turn it into attractive merchandise they sell at a holiday business fair. Solving this problem requires the collection and analysis of data as well as creative thinking. A teacher could provide students with explicit instruction in the use of databases, the generation of numerous alternatives, and creatively thinking of uncommon uses for common waste materials.

In the Unit Plan, Composting: Why Bother?, high-school adolescent students also address the topic of the environment when they engage in the entire process of making new material from waste, as they turn biodegradable garbage into the gardener's "black gold" or rich compost. In this unit, students have the opportunity to practice problem solving as they compete to get organic material to decompose rather than rot. They sell compost for a classroom fundraiser. By having students stop periodically and reflect on the problems they have encountered and how they addressed them, teachers can support the transfer of skills used in one context to other similar situations.

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Designing Effective Projects: Using Knowledge
Creativity

Innovation and Ingenuity

Most educators would agree that creativity is generally a good thing. Yet few teachers have a clear idea of what creative student work looks like or what they can do to improve students' creativity. Fortunately, there is research to help in this area. Creativity is something that all of us have to some degree, and there are techniques teachers can use to help students become more creative.

According to Robert Sternberg, a nationally-respected researcher on the subject, "Creativity is the ability to produce work that is both novel and appropriate" (cited in Armstrong, 1998, p. 3). Highly creative individuals like Pablo Picasso and Albert Einstein have changed the face of the fields they work in by their fresh perspectives and original ideas. For the rest of us, however, "a thought would be considered creative if it is novel to the one who produces it, irrespective of how many others may have entertained that thought" (Nickerson, 2000, p. 394).

Children can be creative in many ways, by seeing new relationships that surprise their classmates and deepen a discussion. By "giving an example, giving a counter-example, questioning, proposing a solution, creating new relationships, providing context, inventing a problem" students can use their creativity to enrich their learning and the learning of others (Daniel, Lafortune and Pallascio, 2003, p. 18).

Creativity takes many forms in children such as a first-grader's surprise ending to a story about her stuffed animals, a fifth-grader's plan for sharing playground equipment fairly, a high-school junior's robot, and a biology student's method for rebuilding the habitat of a local bird. Creative endeavors like these benefit both the individuals who perform them and the society which nurtures them.

Helping students develop their creativity is a worthwhile goal if for no other reason than personal enhancement. A poem that is only read by the poet, an idea to make housekeeping more efficient, an insight into the world around us, may not be known to anyone, but still has the power to make life more meaningful and more pleasurable. Teresa Amabile (1983) argues that anyone with normal intelligence can aspire to be creative in some area, and everyone benefits from the "excitement and color" (Nickerson 1999 400) these creative accomplishments add to our lives.

While having "excitement and color" in our lives is certainly a worthy goal, most of us live in a real world, where we are held accountable for very different outcomes with our students. Why worry about improving students' creativity when success is judged on the basis of academic learning and test scores? Sternberg and Lubart (1999) provide comforting news. They claim that research shows that when creative students are taught and assessed in ways that value their creativity, their academic learning also improves, so teaching to improve creativity can do more than make

a person happier and more productive in society. It can also help students improve their test scores.

Components of Creativity

People often tend to think of creativity as magical and mysterious. Certainly there is something strange and wonderful about the creation of a great work of art or an earth-shattering idea. Those who study creativity, however, believe that extraordinary products are made through essentially ordinary thinking processes, which means we can all develop our creativity to some degree.

Creative individuals possess a combination of intellectual abilities, personality traits, and subject-area knowledge. They have the cognitive ability to deal with complex situations, have a set of tools they can use to generate many ideas, and are able to concentrate completely on a task (Amabile 1983). According to Sternberg and Lubart (1999), creative individuals have what they call a "synthetic ability" to see problems in novel ways, an "analytic ability" to decide which ideas are worth following through on and which aren't, and the ability to convince others that their ideas are worthwhile.

Creativity is more than just the brain, however. People who are very creative also have personality and character traits that contribute to the production of unusual and appropriate solutions to problems. Two of the most important traits are the inclination to take sensible risks and the ability to tolerate high levels of confusion and ambiguity (Sternberg and Lubart 1999).

There has been a great deal of discussion about the relationship between curiosity and flexibility. Being creative requires being able to see things from different perspectives and changing your point of view when the situation demands it. People who are creative also have self-efficacy, and believe in their ability to accomplish difficult tasks and are persistent at overcoming obstacles.

Very creative people are often thought to be highly intelligent. While this is occasionally true, evidence shows that the connection between intelligence and creativity is not straightforward. Sternberg and O'Hara (1999) found people with low IQs are not likely to be exceptionally creative but above 120, there is no correlation between traditional intelligence and creativity. They even suggest that individuals with very high IQs may be rewarded so much for their analytical thinking that they do not reach their creative potential.

Technology and Creativity

In her 2002 review of the literature on creativity and technology, the educator, Avril Loveless, explains the complicated relationship between creativity and technology. Tools such as digital audio, video devices, and computers can contribute to creative processes in a variety of ways. She explains that the features of technology such as provisionality, interactivity, capacity, range, speed, and automatic functions, allow students to do things that they could not do, or at least could not do as efficiently, without technology.

Because computers allow students to make changes and try out alternatives and keep track of how well they work, they are useful for revising and editing. The interactivity of computers allows users to receive and give feedback from processes or other individuals. Technology gives students access to great amounts of information that would have been unimaginable just a few years ago. Because computers can perform complex operations easily and quickly, users can put their efforts into more high-level processes such as the analysis, interpretation, and synthesis of information.

In the classroom, teachers can use technology to help students to brainstorm and evaluate ideas, make connections, collaborate, and communicate. They must remember, however, that it is not the access to technology that encourages creativity, but the creation of an environment in which technology can be used to accomplish goals in creative ways.

Teaching Creativity

Some people may argue that it is impossible to teach creativity, that it is an innate quality like

musical talent. However, like a talent, people can work to make themselves more creative, and teachers can help their students develop their creativity.

The classroom environment has a big impact on the development of creativity in students. Some suggestions for creating an environment that encourages creativity in a project-based classroom are:

- Have a variety of materials and equipment available
- Reduce the negative consequences of risk-taking
- Expose students to a wide range of creative products
- Make available resources on a wide range of topics so students can find something that interests them and sparks their imagination
- Allow flexibility in time and classroom arrangement
- Encourage students to collaborate on projects
- Make sure that students have some quiet time during project work because noise can inhibit creativity
- Connect students with creative individuals in the community
- Set an example by thinking creatively yourself and sharing your products, your processes, and your joy in your accomplishments

Success in any aspect of education is linked to student motivation. Research indicates that intrinsic motivation enhances creativity while extrinsic motivation generally undermines it. (Amabile 1983). Competition for prizes for the “best” product has a detrimental effect on creativity, possibly because the energy and commitment necessary to produce novel ideas takes a great deal of effort, which extrinsically motivated individuals are unlikely to expend (Collins and Amabile 1999).

The issue is not black and white, however. Different kinds of motivation may be effective at different stages of the creative process. While students are exploring a problem and trying to think of ideas, they may be intrinsically motivated. On the other hand, extrinsic rewards may encourage students to learn the skills they need to complete a task or to persist when the initial enthusiasm wears off (Collins and Amabile 1999).

Research has shown that explicit instruction in strategies that produce creative products can help students become more creative (Runco and Sakamoto 1999). Strategies such as brainstorming, exploring multiple options, and evaluating validity, can be taught and assessed in a variety of ways and contexts. Forcing students to compare unlike concepts can also bring out creative responses.

Teachers must take care with the use of examples of finished products. Although providing students with examples is generally considered to be beneficial, participants in a research study created products that contained features of the examples even when they were specifically told to create something as different as possible from the example (Ward, Smith and Finke 1999). It may be more useful to provide students with examples of processes that experts use than with examples of possible products.

All students have a creative potential within them. Whether they realize that potential depends only partly on their motivation and ability. By using language that encourages creativity and creating an environment which challenges and supports students in their creative efforts, teachers can help students think and act more creatively.

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Designing Effective Projects: Teaching Thinking
Environments that Encourage Thinking

Creating a Thinking Classroom

Students learn to think in thoughtful classrooms, places where students enthusiastically grapple with important issues by considering multiple perspectives, developing informed opinions, and effectively communicating their opinions to others. Creating this kind of environment is the biggest challenge teachers face, but teaching in such an atmosphere is not only rewarding, but enjoyable for students and teachers alike.

In order for students to develop their thinking skills, they must feel comfortable taking risks and failing occasionally. Project-based learning, in which students can exercise their thinking muscles on authentic problems, provides an ideal structure for infusing the teaching of thinking into curriculum content.

Language of Thinking

A thoughtful classroom is infused with a "language of thinking" that is used by both teacher and students. This language highlights the process of thoughtful learning and differentiates between thinking that is shallow and superficial and thinking that is deep and meaningful. Vygotsky (1986), the father of constructivism and student-centered learning, reminds us, "Thought is not merely expressed in words; it comes into existence through them" (p. 218). Talking helps people think and it helps students learn to think.

Teacher Questions

One of the most basic kinds of language used in the classroom is teacher questioning. Teachers are often encouraged to ask higher-level questions to improve their students' abilities, asking more "why" and "how" questions and fewer "what" and "when" questions. There is no evidence, however, that answering these kinds of questions alone has a direct effect on students' ability to think.

Wegerif (2002) illustrates this conclusion with the example of a teacher asking "Why did Huck Finn's father abduct him?" This question could elicit deep thinking and may help some students improve their thinking abilities but, as he explains, if students "are in the habit of guessing or making hasty judgments about what causes things to happen," they will just continue to practice patterns of shallow thinking.

Some, so-called deeper questions, ask students for subjective judgments: "What did you think of the poem?" "Should we clone human beings?" Students can usually answer such questions easily, but without having to justify and support their opinions, they are not likely to grow as thinkers (Appelbaum, 2000). In a thinking classroom, the teacher's response to a "why" or "how" question is "How do you get that?" "What reasons do you have?" "Where do your reasons come

from?" "What about this other point of view?" These kinds of questions from a teacher and from students become part of the culture of a thoughtful classroom and ensure that there is more to answering a good question than a flippant, easy response.

Building classroom learning around good questions is an important part of encouraging thinking in students, but it is not sufficient. The questions must be accompanied by appropriate feedback, assessment, and instruction in how to think about them.

Student Questions

A greatly neglected component of a thinking classroom is student questions. In the traditional classroom, students answer questions; they don't usually ask them. For years, students have sat in classrooms where the teachers ask the questions to which they already know the answer. Genuine perplexity, which is at the root of all learning, is rarely admitted.

The culture of a thinking classroom must be built around genuine questions, questions which honestly confuse teachers and students. The switch from answering to asking questions will not happen quickly or painlessly for most students. Risk is involved in caring about something enough to confess lack of knowledge about it. Nevertheless, creating an environment in which students freely question the subject matter, the teacher, and each other is critical for developing thinking.

J. T. Dillon (1988), education professor, provides some advice for teachers to encourage student questions:

- Provide a place for student questions in your instruction and wait for them by
    - Periodically during a unit asking students to write down questions they have about the topic being studied
    - Basing a lecture, discussion, or exam on students' questions
    - Inviting students to question you or other students during discussions
    - Teaching students to question texts and other instructional materials
- Welcome questions.
- Sustain the question by:
    - Reinforcing and rewarding perplexity and the spirit of inquiry
    - Helping students come up with a way to answer the question
    - Finding out what the question is from the student's point of view
    - Appreciating the student's knowledge revealed by the question
    - Expressing genuine interest in the question

Good thinkers are good questioners, and with many students, this skill does not happen automatically or by accident. In a thoughtful classroom, the encouragement of student questions is very important.

Reasoning

Weil (2000) speaks about teaching students the "dance of reason." To perform this dance, students must use language as a tool to form, analyze, and defend arguments. She describes the various steps to the dance.

- Recognizing and evaluating evidence
- Examining their own and others' assumptions
- Questioning deeply
- Understanding the difference between relevant and irrelevant information
- Verifying sources of information
- Withholding judgment until you have enough information
- Evaluating perspectives and interpretations
- Recognizing contradictions
- Exploring interpretations

In thinking classrooms, words like evidence, point of view, and credibility are sprinkled throughout every subject area and every activity. They are occasionally the focus of instruction, but they are always the focus of learning.

Metacognition
Metacognitive talk, as Marzano's (1998) research shows, is one of the most powerful tools for improving student learning. Teachers are often reluctant to use thinking as a subject of conversation. Their apprehension may stem from most teachers' unfamiliarity with their own thinking processes and the awkwardness that usually accompanies initial attempts in this area. A little practice will help teachers become comfortable doing this and when they see the benefits, it will become a regular part of their instruction.

Two ways to foster metacognition are through learning logs or discussions. Prompting students to answer questions about their thinking can be very effective in helping them grow as thinkers. At the beginning of a project, students can think about how they are going to set goals and plan their work. During the project, they can ask themselves how their thinking strategies are working and how they might modify or change them to be more effective or efficient. When the project is completed, they can think about what they learned from the way they approached this project that will help them do better on the next one.

Room Arrangement

Clearly, thinking can happen in almost any kind of physical environment. Abraham Lincoln did it with a candle by the fire, and political prisoners have done it in solitary confinement in a cell. Most people, however, do better with a little support from the physical world around them.

Most deep thinking requires, at least at some stage, talk. Thinking classrooms need to be full of it, so an environment that makes it easier for students and teachers to talk to each other is likely to encourage deep thinking. Tables or desks arranged in groups facilitate meaningful interaction among students although a clever teacher can find ways for students to get together even in rooms where the desks are nailed to the floor in straight rows.

The best possible room arrangement is flexible. A teacher needs to be able to separate students and group them as necessary. There should be a place for one-to-one conferences as well as places for students to work in groups and places for students to be by themselves. All of this can happen just as well in a traditional classroom as in a large open space as long as a teacher is committed to providing a physical environment that supports student thinking.

Students also need access to the resources for thinking in order to complete authentic projects. A classroom library, scientific equipment, math manipulatives, maps and globes, animals and plants, give students interesting and meaningful fodder for thinking. Along with information, students also need access to materials for publication and presentation such as, chart paper, markers, cast-off clothing and household items for plays and skits, clay, paints, string, and a variety of other materials which bring out the creative instinct in students and appeal to a variety of learning styles.

Technology

Computers, digital cameras, and other types of technology can play an important role in a classroom that fosters thinking. In project-based learning classrooms, these tools provide a way for students to think about content as well as a way for them to share and explain their thinking. Email, electronic discussions, even a project visible on a computer screen where a group of students can look at it and discuss it together can help to make processes explicit and open for discussion.

Internet access can be a valuable tool in developing thinking in students by providing a structure for dialogue about thinking processes. In electronic environments, students do not have to compete with others for the right to speak. They can also take their time to compose their thoughts, which is important for students with learning disabilities and for non-mainstream language speakers.

Software that supports statistical analysis, visual representation of information through graphic organizers and multimedia presentations, along with traditional word processors, are essential in

the 21st-century classroom. Like any teaching method, however, access to computers does not guarantee deep thinking any more than access to great literature guarantees sophisticated literary analysis. This is especially true of computer games where, doubtless, students can be exercising higher-order thinking. Without explicit instruction in how to transfer those skills to other contexts, there is not likely to be much learning from technology for most students.

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Instructional Strategies

Designing Effective Projects: Instructional Strategies
Tapping Prior Knowledge

About Tapping Prior Knowledge
For a student, new content can be overwhelming. There are new vocabulary words, ideas and concepts that others seem to understand easily or have experienced before. Teachers can help their students make the transition from the unfamiliar by tapping students' prior knowledge. Research shows that we can jump-start learning by accessing preexisting attitudes, experiences, and knowledge and bridge the gap between what is being taught and what is already known.

Teachers can also use prior knowledge to make instruction more meaningful. Many researchers (Peshkin, 1992; Protheroe & Barsdate, 1992; and Lee, 1992) emphasize the importance of incorporating a student's cultural background into the curriculum. As the world changes, students must learn to understand and appreciate the experiences and contributions of people from different backgrounds. A culturally-responsive education links curriculum, instruction, and assessment to the students' experiences, language, and culture, in other words, to their prior knowledge.

Additionally, this instructional strategy defines a proper starting place for instruction and the sequence of instructional activities. As stated by educational psychologist David Ausubel, "the most important single factor influencing learning is what the learner already knows."

Make it Happen in Your Classroom
Exercises to access prior knowledge can be used at any grade level, with any content area, and with any subject. Prior knowledge is the proper entry point for instruction because it builds on what is already known, supports comprehension, and makes sense of new learning. (Kujawa and Huske, 1995) Tapping students' prior knowledge is a great way to start a new unit or lesson and an even better way to get students involved right from the start. Referring back to this knowledge throughout a unit of study will keep students in tune to their learning and keep the material relevant.

Examples Across the Curriculum
From simply asking questions aloud to formally using a journal to document their prior knowledge, there are a wide range of activities teachers can use with their students. The following examples can be used across the curriculum and at any grade level.

Written Activities >
Activities that prompt students to write and reflect about what they already know about new content. These include quick writes, journals, and learning logs.
Know-Wonder-Learn Charts (K-W-L) >
An instructional technique used to activate students' prior knowledge, set goals and record new knowledge gleaned from a unit of study.
Thinking Activities >
Activities that tap students' thinking by giving them an opportunity to make predictions, list and rank ideas, and make analogies based on their prior knowledge.
Discussions >
Teacher to student and whole class discussions are great ways to activate students' prior knowledge by allowing them opportunities to orally share their ideas and discuss their opinions.

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Designing Effective Projects: Tapping Prior Knowledge
Written Activities

Learn About Written Activities

Written activities that prompt students to write and reflect upon what they already know help students tap prior knowledge.

Quick Writes

Quick writes are usually done at the beginning of the lesson or unit to get students to think about the new content or respond to a prompt. The writing is not graded and allows students the freedom to express their ideas and make personal connections to the new content being addressed. Occasionally, teachers will challenge students to write or brainstorm their ideas within a time limit. Once they are completed, these quick writes are a great way to stimulate class discussion.

Example Prompt: Take five minutes to write about what friendship means to you. Use examples and brainstorm characteristics of a good friend.

Example Response: Friendship means a lot to me. I have many friends. We like to play together and tell each other our secrets. My friend, Melanie, spends the night at my house. She is kind, caring and funny. That's what I like about her. Friends should never be mean and if they are, they should apologize and say they're sorry. Friends are important people. Everyone should have one.

Journals

Another way to prompt students and activate prior knowledge is journal writing. Like a quick write, but longer and not necessarily timed, journal writing allows students to respond to a prompt or write what they already know about a topic. These journal responses may be collected and reviewed to give feedback to the student. The journal may cover several topics over the course of a semester or quarter. The entries could be shared with partners or small groups to spark discussion. If graded, journals should not be graded for content but rather for effort, completeness, and thoroughness.

The wonderful thing about journaling is that it can be used across the curriculum and is not just a language arts activity. Journaling is just as effective in a mathematics classroom as it is in an English classroom. Allowing students to organize their thinking, respond to new content, and make personal connections without the threat of grades, is very important in tapping students' prior knowledge.

Example Journal Prompt: How do you feel about voting? Give examples and support your opinion.

Example Journal Entry: I believe in voting. I believe that democracy is a privilege even if your vote is one voice in a million. It's hard to see how one vote will make a difference when a simple majority wins. But that is why it is important to vote, your vote may make the difference. Recently,

a governor in Washington state was elected by a difference of 200 or so votes in a race where several millions voted.

Learning Logs
Learning logs are an excellent way to get students to record thought processes, ideas, and questions throughout a unit of study. Learning logs are similar to quick writes and journals but focus on documenting a learning experience. Students describe what they investigated, accomplished, or learned in an activity or class exercise. Logs are appropriate across the curriculum and grade levels. Questions, prompts, or free writes can be incorporated into the learning logs. They can be used by teachers as informal ways to check for student understanding. Many times, the teacher uses the learning logs as a way to have a written discussion by responding to the student's entries and posing more thought provoking questions to them. For younger students, words and pictures can be a way to record ideas and thoughts. These can be hand or word processor written documents that students maintain throughout a project.

Example Learning Log
This is an example student entry based on The Great Bean Race unit plan.

Question: What do you know about plants?

Student entry: January 14
I know a lot about plants. We have plants at my house. I know you have to water them or they will die. I know they have to be planted in dirt so they can grow. I know there are lots of types of plants. I know there are ferns. That's the type of plant my mom has. I know plants grow outside and they are pretty.

Teacher entry: January 15
It sounds like you know a lot about plants. It is very important to water plants and make sure they don't die. I think it's great that you know what a fern is. That's the type of plant I have at my house too. How has your plant been doing?

Question: What has happened to your bean plant since you planted it? Why do you think these changes have happened?

Student entry: January 30
We planted our bean plant a week ago. It has started to sprout and some small buds are starting to show. We planted it in a soil and clay mixture and decided to water it every day. We are putting it in natural sunlight for part of the day and then in the shade the other part. We thought this would be smart because plants in the outdoors don't get sunlight all day long and we wanted our plant to grow like the plants outside do. We think our plant has started to grow because we did these things and we know that plants need soil, water and sunlight to grow.

Teacher entry: February 1
I like your plan that your group has made. It sounds like you are doing many important things to help it grow. I'm glad to hear that you have started to see your plant change and begin to sprout. These are important changes. I'm looking forward to hearing how big your plant grows. Do you think your bean plan is going to help make your plant the tallest? How are the other plants growing compared to your plant?

Question: Why are plants important to humans and animals?

Student entry: February 10
Our plant is now 4 inches high. It's not the tallest one in the class. We think it's because we are doing half sunlight and half shade. The race isn't over yet, so maybe it will grow taller.
Before we started studying plants I thought plants were pretty and that some animals ate them for their food. Now that we have planted and studied our own bean plants I know how important plants are to humans. They give us our oxygen! It's amazing. Without plants we would die. I did

not know that! They also give other animals their food to eat. I knew that! But now I know that they are an important part in the food web. They give us our oxygen but we give them carbon dioxide so they can make food to live. They eat a different kind of food than we do but they need it to live. Plants are very important. More important than I ever thought they were.

Teacher entry: February 12
Wow! You have learned a lot. You knew a lot before we started learning about plants but now you know a ton! Isn't it amazing that plants give us our oxygen and we help them make food by breathing out carbon dioxide? I was so surprised when I learned that. I'm so glad you've learned so much while studying plants!

Designing Effective Projects: Tapping Prior Knowledge
Know-Wonder-Learn Charts

Learning About Know-Wonder-Learn Charts

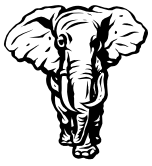
A Know-Wonder-Learn (K-W-L) chart is one of the most commonly used graphic organizers to tap students' prior knowledge. This simple chart activates students' prior knowledge by asking them what they already know about a particular subject. This allows the students to make personal connections before the content is deeply explored. The students brainstorm their ideas on the Know section of the chart. Then the students independently or collaboratively brainstorm questions they have about the content in the Want to Learn section. Once students begin to answer these questions during a project, they record this information on the Learn section of the chart.

By using this chart, students are constructing meaning from what they've been learning, comparing their new knowledge to what they already know, and are able to clarify their ideas. This also keeps students focused and interested in the content and is a way to keep track of what they are learning. Ultimately, the chart could be used as a document for an assessment portfolio to show what the student has learned.

A K-W-L chart can be used across the curriculum at any grade level. It can be used to start a new unit of study and referred to throughout the unit. It is usually not a graded document but rather a place for students to write down their ideas and questions without the fear of being judged or graded. This chart also helps with student organization and can be a starting point for peer-to-peer or whole-class discussion.

Example K-W-L Chart
This sample K-W-L chart is from the Unit Plan, **African Adventure Safari**.

Name_____



K-W-L Chart
For
The Cheetah

Write about what you **know** about your African animal. Then write questions about what you **want** to know. When we have finished the unit, you can write about what you've **learned**.

What I **Know**:	What I **Want** to Know:	What I **Learned:**

Example *A cheetah eats antelope.*	***Example*** *How does a cheetah kill the antelope?* *Where do antelope live?* *How many antelope will a cheetah eat in one week?* *Do antelope ever escape from the cheetah?*	***Example*** *Cheetahs will run at 70 mph to catch the antelope. They find the antelope grazing on the African savannah. The cheetahs have to suffocate the antelope because they have small jaws and can't kill in one bite.*

Designing Effective Projects: Tapping Prior Knowledge
Thinking Activities

Learn About Thinking Activities

Thinking activities are used to tap students' prior knowledge by giving them an opportunity to create lists, make predictions, and use analogies. By using these activities, students are put in control over their learning and allowed to make personal connections to new content how they see fit.

Organized Lists

Making organized lists that rank items in an order that makes sense to the student is one way to use helps students organize what they know as way of tapping prior knowledge. The *Visual Ranking Tool*:

- Is an online thinking tool for ordering and prioritizing items in a list
- Helps students analyze and evaluate criteria for their decisions
- Compares reasoning visually to promote collaboration and discussion

With the use of this tool, students can use prior knowledge at the beginning of a unit or lesson to rank items and then see how their new knowledge expands their viewpoint over the course of study.

Example Visual Ranking List:

Working in pairs, students are given a list of animals and asked which one most resembles a human. They use *Visual Ranking* to put the animals into order, ranking them on their human-like qualities.

This *Visual Ranking* list comes from the project idea: *Classify Animals*.

Predictions

Another thinking activity that has proven effective at all grade levels and across all curricular areas is the use of predictions. Before the bulk of the content is presented or during the middle of

a unit of study, having students make predictions about what they are going to learn based on their prior knowledge is an important strategy. Students are given an opportunity to make "educated guesses" without the threat of being wrong. Because they have the opportunity to check the accuracy of their prediction, students are more focused and engaged in the content, because they have a "stake" in the knowledge. Usually, if their prediction is incorrect, they are armed with new knowledge to correct their thinking and learn from their previous understanding. The use of predictions also sparks students' higher level thinking by tapping into their evaluative, comparative, and analysis skills.

Example Prompt Prediction: Based upon what you know about frogs and frog habitat what do you predict might happen to a frog if it is taken out of its natural habitat and placed into an artificial one? Why do you think this might happen?

Example Student Prediction: I predict that the frog will eventually die. I predict this because it will have difficulty adapting to a new environment. It may have the same things like water, rocks, and food but it won't be the same as its home in the wild. The main thing that will be missing is the space and the other frogs. Plus, the water in the natural habitat has a balance of the right type of bacteria in the water and it's hard to keep the artificial water the exact same as it would be in the wild. If the aquarium is indoors it might also be hard to keep the temperature just right for the frog. I think my prediction will be right, and I will be sad if it is.

Analogies

The use of analogies as a tapping prior knowledge thinking activity is a quick and easy strategy to use with students. Analogies help to arm students with comparative skills and language to compare what they are learning to what they already know. This strategy gives the student a point of reference and an opportunity to make sense of new content. Analogies are effective thinking strategies for all grade levels and content areas and can help spark student discussions.

Example Analogy Prompt: Now that we have begun to study the eye, can you look at the diagram of a camera and think about how an eye is like a camera?

Example Analogy: Both a camera and an eye have a lens that lets in the light. The pupil of an eye gets bigger and smaller like the aperture of a camera. We've learned that the eye sees things upside down, and so does a camera.

Designing Effective Projects: Tapping Prior Knowledge
Discussions

Learn About Discussions

Teacher-to-student and whole-class discussions are great ways to activate students' prior knowledge by allowing them opportunities to orally share their ideas and discuss their opinions. The art of discussion is an important piece in the learning process. A common mistake many teachers make is to throw out a question or idea and expect most of their students to respond and discuss. It's frustrating and a waste of time for both the teacher and students to listen to a select few students have a discussion.

To conduct successful discussions, teachers need:

- To be armed with the right types of questions and ready to respond to various answers.
- To be able to use "teachable moments" to spark student interest and keep the discussion lively.
- To use the discussion as a jumping off point for new content.
- To pose questions that directly relate to students and their prior knowledge.
- To allow the students to lead the discussion with teacher facilitation and probing.

- To accept all appropriate answers as correct and added responses by others should be encouraged.
- To permit "think time" and use think-pair-share strategies to think about answers before having students respond.

Whole Class Discussions

Using whole class discussions to tap prior knowledge can benefit all students who are participating and listening by connecting what they already know to what they are going to learn. The discussion, if engaging, can get students excited about the new content and how it relates to them. Teachers can also use the discussions as a way to direct and redirect teaching based on student response and interest.

Example Discussion:

Teacher-Whole Class Dialogue: High School

Teacher: Does anybody know what we mean when we use the term "in the trenches"?
Mark: It means like they're really there.
Teacher: Like who's really where?
Mark: Like someone who is where it's down and dirty.
Teacher: Can anyone give me an example of someone who's in the trenches?
Juana: Like a policeman who works on the street. He's right there with the thieves and the drug dealers.
Liz: Not like some politician who says a lot of stuff but doesn't know what it's really like. The cop is really in the trenches.
Teacher: Do you know where the phrase "in the trenches" comes from?
(No answer, so the teacher waits for a response.)
Can anyone guess?
David: Was it maybe from a war?
Teacher: Good guess. Trench warfare was fought in World War I. The soldiers had to dig deep trenches and then stay in them for protection. All the fighting was done in the trenches, so that's where the saying came from. Does anyone know anything else about World War I?
Russ: Weren't the soldiers called doughmen?
Teacher: Close. They were called "doughboys.'
Jenn: Like the Pillsbury Doughboy.
Teacher: Uh-huh.
Jenn: Why were they called that?
Teacher: Good question. Let's write that one down to find the answer to. What else do you know about World War I? Who fought in the war?
Luke: It was fought against Hitler.
Xavier: No, that was World War II.
Luke: Oh, yeah, right.
Teacher: That's a common mistake that people make about World War I. Does anyone have any idea why?
Liz: Because we fought against Germany in both wars?
Teacher: That's true. Any other thoughts?
Micki: Was the Red Baron in World War I?
Teacher: Who was the Red Baron?
John: He was a famous fighter pilot.
Teacher: That's right. Anything else? Does anyone know why the war started?
(No responses)
How about who fought in the war?
Corey: Well, the United States and England and France.
John: And Germany.
Teacher: Any other countries?

Mark: I think that maybe I have World War I and II mixed up in my brain. Were there Jewish concentration camps in World War I? Were there Nazis? I'm not sure.
Teacher: It sounds like you all have some bits and pieces of knowledge about World War I, and some of it might be wrong. While we're studying that war in the next unit, you'll learn more about the War itself and also more about the role that the United States has played in foreign affairs since then.
Teacher: I want you to think about some reasons why countries go to war. In your learning logs, describe some reasons and some examples you could use to demonstrate these ideas. I will respond to them this week.
Juana: What if we don't know of any examples?
Teacher: Not a big deal. Just make some predictions as to why countries go to war and if you don't have examples that's okay. You will as soon as we get further into the unit.

Student-Teacher Discussions

Individual student-to-teacher discussions are another way to tap students' prior knowledge on a smaller scale. Setting aside time to discuss needs and interests helps students to make personal connections to content. While students are working, sitting down and discussing work one-on-one is an excellent way to make individual opinions and knowledge noticed and recognized. These discussions can be quick and informal, but they let the student know what they have to say is important. It also gives the teacher an insight into the student's thoughts and shows how to direct further teaching of the topic.

Example Discussion: Elementary

Teacher: How are you doing on your K-W-L chart?
David: Fine. I know a lot about weather. My mom and dad watch the Weather Channel.
Teacher: That's great! I see you wrote that you know about tornadoes and how they are created.
David: Yeah. I know about air currents and how tornadoes happen on land and hurricanes are created over water. I learned about that from a book I have at home.
Teacher: It sounds like you know a lot about weather and like to read about it. Do you have any books about seasons?
David: Yeah. I have a great one. I can bring it in to share. It talks about all four seasons and the changes that happen in weather and with animals and all that kind of stuff.
Teacher: I think you are going to have a lot to share about seasons when we start this unit. I am so excited I can look to you as an expert. Great work, David.

Designing Effective Projects: Instructional Strategies
Cooperative Learning

Learn About Cooperative Learning

Two heads *learn* better than one. This variation on the classic saying is very true for students in a classroom. Cooperative group work is an important part of an effective classroom. However, there is much more to group learning than just having students "work together." The primary goal of group work is to get students actively involved in their learning where there is an accepted common goal. This grouping allows students to work together to maximize their own and each other's learning.

"In a cooperative learning situation, interaction is characterized by positive goal interdependence with individual accountability." (Johnson & Johnson 1998)

One frustration many teachers, students, and parents have with cooperative groups is that many times the high achieving students do most of the work while others ride along on their coattails. In

order for cooperative grouping to be effective and make good use of classroom time, students must have clear role responsibilities, group goals, and individual accountability.

In a classroom setting, cooperative groups give students opportunities to learn from and teach one another under "real" world conditions. "By the 1990's, teamwork became the most frequently valued managerial competence in studies of organizations around the world" (Goleman 1998). We can prepare our students to enter the working world by giving them these valued opportunities to work together to create products and solve problems

By organizing a classroom around cooperative group work, the ultimate goal is to get students actively involved in their learning. Grouping students in pairs or small groups, increases their chances of involvement. Students feel less pressure when asked to complete a task with a peer than they do completing it independently.

Cooperative learning should be used strategically. There is a time and place for grouping structures. "Research has established that the cooperative structure outperforms competitive and individualistic structures academically and socially, regardless of content or grade level." (Kagan 1997) Students often view school as a competitive enterprise where they try to outdo their classmates. Research shows that students are more positive about school, subject area, and teachers when they are provided structure to work cooperatively (Johnson & Johnson).

Make it Happen in Your Classroom

With time and patience any teacher at any grade level can incorporate cooperative learning into their instruction. The keys to success are in holding high expectations, keeping students individually and collectively accountable, and creating a classroom environment where cooperation is encouraged.

Cooperative Grouping Across the Curriculum

There are many cooperative grouping strategies, each is supported by research and can be used across grades and subject area classrooms.

Reciprocal Teaching >

A cooperative grouping strategy that calls on students to become "the teacher" and work as a group to bring meaning to text.

Jigsaw >

A cooperative learning technique that promotes better learning, improves student motivation, and allows greater amounts of content to be studied and shared by students in a group.

Brainstorm Groups >

A cooperative learning strategy that calls upon groups of students to brainstorm thoughts and build upon one another's flow of ideas in a safe environment.

Think-Pair-Share >

A cooperative discussion strategy made up of three stages of student action where students talk about the content and discuss ideas before sharing with a whole group.

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Effective Cooperative Learning

Make it Happen in Your Classroom

Providing “practice” activities to complete a task cooperatively is one way to get students working in small groups. Through teambuilding exercises where students construct something together, brainstorm a topic of interest, or solve a problem, they can practice the skills they need to be successful when working in groups. These activities help to establish norms of desired behavior and provide necessary feedback to the groups. Taking the time to teach students how to get the most out of working with peers can make cooperative learning more efficient and productive.

Cooperative learning groups may last for one lesson or over the course of a long-term project. There are multiple ways these group interactions can be embedded into an everyday classroom learning experience. To get started in a more formal cooperative group, the teacher would:

- Introduce the lesson
- Assign students to groups
- Assign roles
- Set expectations for individual contributions to the group
- Make sure students have the necessary materials and resources

The teacher then explains the process and information needed to complete the activity. The student groups work on the activity until all group members have successfully understood and completed it.

The role the teacher plays during this cooperative structure is very important. While the groups are working, the teacher moves from group to group monitoring the interaction, asking and answering questions, and redirecting attention. This is also a good time to take anecdotal records of individual students on how they are performing in their group. Once the activity is completed, the teacher evaluates the performance of each student, and students evaluate their own contributions as well as those of their group members.

In an informal cooperative group, the teacher might set up groups:

- To focus student attention
- Have students get another’s point of view
- help to ensure students are processing the material being taught

Technology can play an integral role in supporting students as they work cooperatively on projects. Students can communicate with other students and connect to experts in the field. For example, while students are studying poetry from around the world they can connect to published poets through email and Web sites, get feedback from experts, or share ideas. They then can create group products using multimedia software and share their final project with an e-pal.

By using cooperative learning strategies in the classroom, Johnson and Johnson (1999) found that teachers are providing students with:

- Positive interdependence
- Face-to-face interaction
- Individual and group accountability
- Interpersonal and small group skills
- Group processing

The positive benefits of cooperative grouping far outweigh any of the negative. Using these strategies will benefit not only students but teachers by creating a student-centered environment where people interact and work together successfully.

Reciprocal Teaching

Reciprocal Teaching Strategy

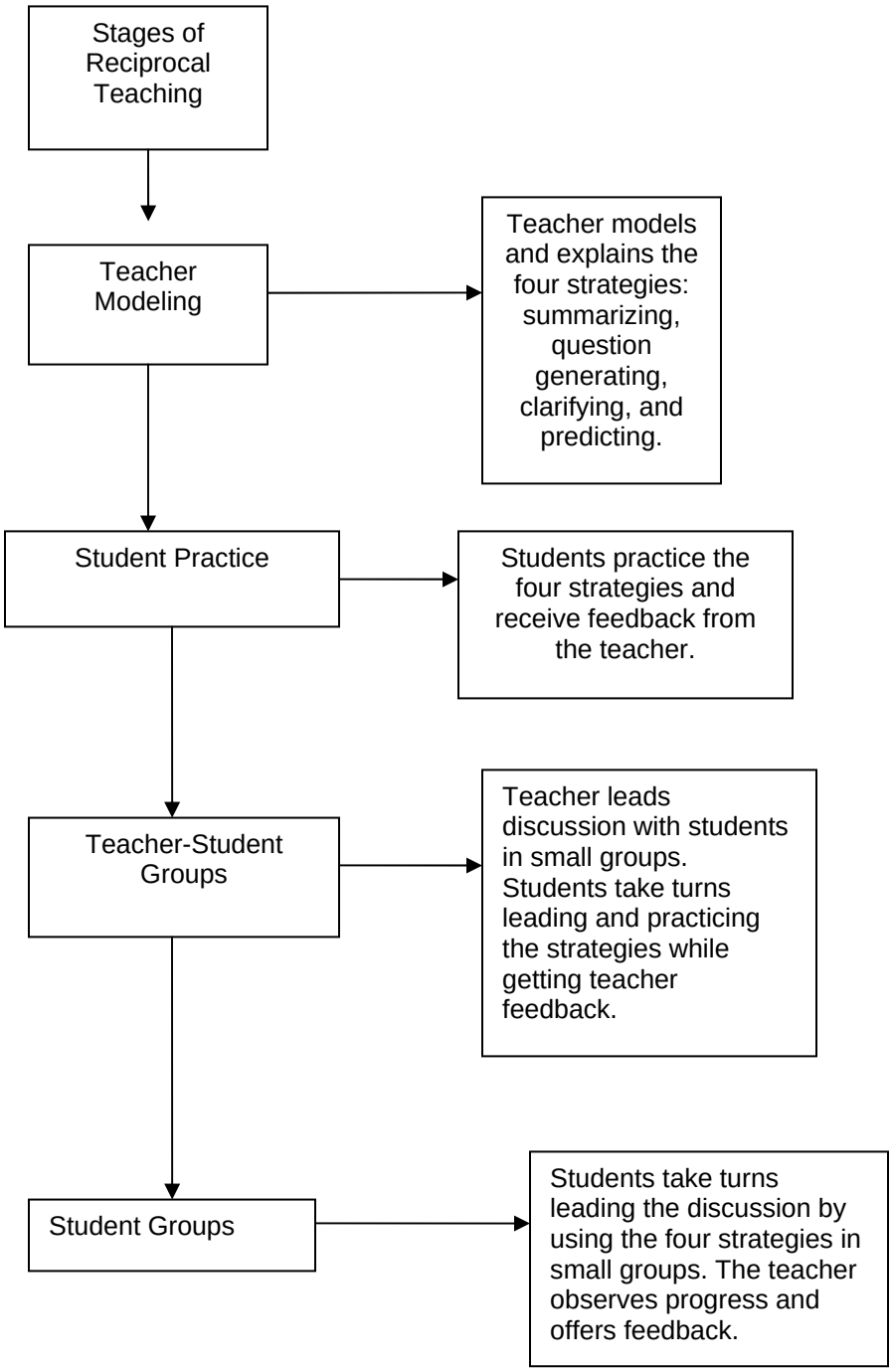
Reciprocal teaching (Palincsar, 1984) is a cooperative grouping strategy that calls on students to become “the teacher” and work as a group to bring meaning to text. Teachers and students engage in dialogue regarding segments of text. The dialogue is structured by using four strategies:

- Summarizing
- Question generating
- Clarifying
- Predicting

It is important that each of the above strategies has been taught and practiced before reciprocal teaching takes place. The stages of reciprocal teaching are easy to set up.

Stages of Reciprocal Teaching Set-Up

The teacher hands out a passage of text to each student in the group. Each student reads the passage and writes summarizing, clarifying, or predicting questions related to what they’ve read. The “teacher” of the group, asks one of the questions. The “teacher” is the lead group member who starts off the questioning. One group member responds, using the text to support their answer. The student, who answers the question, then asks a question and the process repeats.



Adapted from: http://condor.admin.ccny.cuny.edu/~yq6048/*

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Designing Effective Projects: Cooperative Learning
Jigsaw

The Jigsaw Strategy
The jigsaw cooperative-learning technique promotes better learning, improves student motivation, and allows greater amounts of content to be studied and shared by students in a group. The jigsaw technique was first developed by Elliot Aronson and his college students. The technique allows for:

- An efficient way to learn content
- Development of listening, engagement, and empathy skills
- A way for students to work independently
- Interaction among all students

Students are divided into small groups of five or six. Each group's task is to learn about one aspect of a subject area and become "experts" on the subject. In this "expert" group, students do research together and collaboratively create a report or presentation. Each student is also individually responsible since they will teach others about the content. Once students have become "experts" they are reassigned a new group. Each new group is formed with "experts" from the original groups. The task for each "expert" is to teach the others in their group about the content they have studied. Once all "experts" have presented, each group member has learned five or six new aspects of the subject area and is ready to take an exam, write an essay, or group with another "expert" to create a multimedia presentation.

Designing Effective Projects: Cooperative Learning
Think-Pair-Share

The Think-Pair-Share Strategy
Think-Pair-Share is a cooperative discussion strategy where students talk about the content and discuss ideas before sharing with a whole group. It introduces the elements of "think time" and peer interaction, which are two important features of cooperative learning. Think-Pair-Share's purpose is to help students process information, develop communication skills, and refine their thinking.

With this strategy the teacher:

1. Poses an open-ended question or problem
2. Gives students a minute or two to think about their answer, pairs students to discuss the answer and share ideas
3. Gives opportunities for students to share their response with a small group or the whole class

Because students have time to think about their answer, then share with a peer and get a different perspective, they may be more willing and less apprehensive about sharing with a larger group. It also gives them time to change their response if needed and relieves the fear of giving the "wrong" answer.

Example
Teacher: I have a question I would like you to think about before we begin our new math unit on fractions. Can you think of places where we use fractions in our every day lives? I would like you to use Think-Pair-Share to talk about your ideas. Take a few minutes to think about your responses and when I signal, turn to your partner and share your thoughts. You will be sharing your responses with the class. (Teacher waits two minutes while students think about their ideas.) Now turn to your partner and discuss what you've thought about.

Mark to Natalie: I was thinking that we use them when we share food. Like a pizza. If you have eight slices of pizza and you want everyone
to have the same amount of pizza you have to count out the slices. What did you think of?
Natalie to Mark: I was thinking of food too, but then I thought about how money is kind of like a fraction. Like four quarters equal a dollar
and five dimes equals fifty cents.
Teacher: Now that you and your partner have had a chance to share ideas, choose which one of you will share your ideas with the whole group.
Mark: Natalie and I talked about how food can be made into fractions, like pizza. We also talked about how money is like a fraction. There are smaller amounts that equal bigger amounts, and we think that is what a fraction is.
Teacher: Both of the ideas are good examples of using fractions in our every day lives. Thank you for sharing.

Designing Effective Projects: Cooperative Learning
Brainstorming

Brainstorming Structures
The use of cooperative brainstorming is an effective and valuable strategy that calls upon teams of students to brainstorm thoughts and build upon one another's flow of ideas in a safe environment. With creative groupings, students have opportunities to work together and learn important content at the same time. Dr. Spencer Kagan, an expert on cooperative grouping structures has created a myriad of cooperative grouping structures to use with students of all ages. The main goal of these structures is to promote:

- Participation in structured interactions
- Equal participation
- Student interaction
- Effective communication
- Cooperative learning as part of any lesson

Through many years of research and training, Dr. Spencer Kagan has refined and developed over 160 structures. All of these give teachers a well planned way to group students and teach them important content in engaging ways.

Check out Dr. Kagan's Web site to read articles and learn more about these brainstorming structures: www.kaganonline.com/KaganClub/FreeArticles.html*

Designing Effective Projects: Instructional Strategies
Questioning

Learn About Questioning
Questioning is at the heart of good teaching. Choosing the right types of questions to ask students is necessary to spark thought-provoking answers and engage students in productive discussions. The instructional strategy of questioning is about asking probing and challenging questions that call for higher cognitive thinking skills such as analysis, synthesis, and evaluation. By asking challenging questions, we call upon students to explore ideas and apply new knowledge to other situations.

Using different types of questioning allows students to think in different and unique ways. At the core of a project-based learning classroom are enduring Essential Questions and higher level Curriculum-Framing Questions. These questions are posed at the beginning of a unit of study, and students continue to explore and revisit these questions throughout.

Questions that require students to defend or explain their positions are open-ended questions. Closed questions are limiting and allow for one or two students to answer either correctly or incorrectly. Open-ended questions are probing and encourage students to think about several ideas. There isn't just one correct answer. By posing open-ended questions to a group of students, the amount of ideas and answers are limitless. Open-ended questions:

- Tell students what is valued and what is important.
- Elicit a range of responses.
- Involve teacher and student communication.
- Must be clearly stated.
- Stir discussion and debate in the classroom.

Effective questioning involves both teacher and student. It is important for the teacher to give "wait time" before asking for responses. Wait time is defined as the amount of time that lapses between a teacher-initiated question and the next verbal answer given by a student. This allows students the opportunity to reflect and think before they speak. Allowing many student ideas, rather than just a couple, is imperative as well. All who want to share should have an opportunity to do so. If time does not allow, these students should have a place to go such as a journal, a learning log, or a whiteboard, to record ideas that can be discussed at a later time.

Make it Happen in Your Classroom

Effective questioning should be used at all grade levels and with all subjects to engage students in the content being taught.

Elaborating, Hypothetical, and Clarification Questions >
See examples of different types of questioning techniques that can be used with students at all levels.
Socratic Questioning >
Read about the Socratic questioning technique and how to use it in the classroom.

Designing Effective Projects: Questioning

Elaborating, Hypothetical, and Clarification Questions

Questions for Different Kinds of Thinking

Different kinds of questions generate different kinds of thinking. These definitions and examples describe three kinds: elaborating, hypothetical, and clarification questions.

Questioning Technique	Definition	Examples
Elaborating Questions	These questions help to extend and broaden the importance of the meaning. Students can elaborate on the question making it more personal to them.	• *What are the implied or suggested meanings?* • *What does this mean to you?* • *How could you take the meaning farther?* • *What could the next step be?*
Hypothetical Questions	These questions help to explore possibilities and test theories. These are the "what would happen if…" questions, allowing students to use their imaginations based on the facts they have learned.	• *What if the earth had no sun?* • *What if the polar ice caps melted?* • *What if Charlotte in Charlotte's Web had lived?* • *What are the possible pros and cons?*
Clarification Questions	These questions help to define words and concepts and clarify meaning.	• *How did the character get to this point?* • *How did they gather the data? Was it a reliable process?* • *What is the sequence of ideas and how do they relate to one another?*

Designing Effective Projects: Questioning
The Socratic Questioning Technique

The Socratic Questioning Technique

The Socratic approach to questioning is based on the practice of disciplined, thoughtful dialogue. Socrates, the early Greek philosopher/teacher, believed that disciplined practice of thoughtful questioning enabled the student to examine ideas logically and to determine the validity of those ideas. In this technique, the teacher professes ignorance of the topic in order to engage in dialogue with the students. With this "acting dumb," the student develops the fullest possible knowledge about the topic.

The Socratic Questioning technique is an effective way to explore ideas in depth. It can be used at all levels and is a helpful tool for all teachers. It can be used at different points within a unit or project. By using Socratic Questioning, teachers promote independent thinking in their students and give them ownership of what they are learning. Higher-level thinking skills are present while students think, discuss, debate, evaluate, and analyze content through their own thinking and the thinking of those around them. These types of questions may take some practice on both the teacher and students' part since it may be a whole new approach.

Tips for Using Socratic Questioning:

- Plan significant questions that provide meaning and direction to the dialogue
- Use wait time: Allow at least thirty seconds for students to respond
- Follow up on students' responses
- Ask probing questions
- Periodically summarize in writing key points that have been discussed
- Draw as many students as possible into the discussion

- Let students discover knowledge on their own through the probing questions the teacher poses

Types of Socratic Questions and Examples

The Socratic Questioning technique involves different type of questions. Some examples of these are:

Socratic Question Type	Example
Clarification questions	*What do you mean by…?* *Could you put that another way?* *What do you think is the main issue?* *Could you give us an example?* *Could you expand upon that point further?*
Questions about an initial question or issue	*Why is this question important?* *Is this question easy or difficult to answer?* *Why do you think that?* *What assumptions can we make based on this question?* *Does this question lead to other important issues and questions?*
Assumption questions	*Why would someone make this assumption?* *What is _____ assuming here?* *What could we assume instead?* *You seem to be assuming_____.* *Do I understand you correctly?*
Reason and evidence questions	*What would be an example?* *Why do you think this is true?* *What other information do we need?* *Could you explain your reason to us?* *By what reasoning did you come to that conclusion?* *Is there reason to doubt that evidence?* *What led you to that belief?*
Origin or source questions	*Is this your idea or did you hear if from some place else?* *Have you always felt this way?* *Has your opinion been influenced by something or someone?* *Where did you get that idea?* *What caused you to feel that way?*
Implication and consequence questions	*What effect would that have?* *Could that really happen or probably happen?* *What is an alternative?* *What are you implying by that?* *If that happened, what else would happen as a result? Why?*
Viewpoint questions	*How would other groups of people respond this question? Why?* *How could you answer the objection that _____would make?* *What might someone who believed _____ think?* *What is an alternative?* *How are ____ and ____'s ideas alike? Different?*

Socratic Questioning Example

This questioning dialogue would take place after the unit had been introduced and was well underway.

Teacher:	What is happening to our global climate?
Stan:	It's getting warmer.
Teacher:	How do you know it's getting warmer? What evidence do you have to support your answer?
Stan:	It's in the news all of the time. They are always saying that it's not as cold as it used to be. We have all of these record heat days.
Teacher:	Has anyone else heard of this kind of news?
Denise:	Yeah. I have read about it the newspaper. They call it global warming, I think.
Teacher:	Are you saying that you learned about global warming from newscasters? Are you assuming they know that global warming is occurring?
Heidi:	I heard it too. It's terrible. The ice caps in the Arctic are melting. The animals are losing their homes. I think the newscasters hear it from the scientists that are studying the issue.
Teacher:	If that is the case and the scientists are telling the newscasters, how do the scientists know?
Chris:	They have instruments to measure climate. They conduct research that measures the Earth's temperature.
Teacher:	How long do you think scientists have been doing this?
Grant:	Probably 100 years.
Candace:	Maybe a little more than that.
Teacher:	Actually, it's been studied for about 140 years. Since about 1860.
Heidi:	We were close.
Teacher:	Yes. How did you know that?
Grant:	I just figured that seems like when instruments were available and scientists had the means to measure climate like that.
Teacher:	So, looking at the last 100 year's climate on this graph, what can we say about the earth's climate?
Raja:	The 20th century has become much warmer than previous centuries.
Teacher:	Can we hypothesize why?
Raja:	One word: pollution.
Teacher:	What are you assuming when you say that pollution is the cause for the temperatures to rise?
Heidi:	Carbon dioxide from cars causes pollution and chemicals from factories.
Frank:	Hair spray causes dangerous chemicals to get into the atmosphere.
Teacher:	Okay. Let's take a minute to review what we've discussed so far.

View the Unit Plan, Literature e-Circles to see a Socratic Seminar in practice.