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Preparing Creative and Critical Thinkers

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Teachers can help students become 21st-century problem solvers by introducing them to a broad range of thinking tools.

If you doubt that we live in a world of accelerating change, just consider the everyday life experiences of millions of children and teenagers today:

- They can view live images from every corner of the world and talk with or exchange video images with other young people who live many time zones away.
- They have more technology in their classrooms (and in many cases, in their backpacks) than existed in the workplaces of their parents 20 years ago.
- They will study subjects that were unknown when their teachers and parents were students, and they may well enter careers that do not exist today.
- In contrast with most of their parents, more of today's young people will routinely come into contact with other people of diverse backgrounds and experiences. They will grow up to interact, collaborate, and compete with others around the globe.

Once upon a time, educators might have said to their students, "If you'll pay close attention to what I'm going to teach you, you'll learn everything you need to know for a successful life." It's doubtful that this message was ever entirely true, but it's certainly not true today. We don't know all the information that today's students will need or all the answers to the questions they will face. Indeed, increasingly, we don't even know the questions.

These realities mean that we must empower students to become creative thinkers, critical thinkers, and problem solvers—people who are continually learning and who can apply their new knowledge to complex, novel, open-ended challenges; people who will proceed confidently and competently into the new horizons of life and work.

In education, we routinely teach students how to use various sets of cognitive tools to make academic work easier, more efficient, or more productive: for example, research methods, note-taking strategies, or ways to remember and organize information. In teaching thinking, we need to give students cognitive tools and teach them to use these tools systematically to solve real-life problems and to manage change. These tools apply to two essential categories: creative thinking and critical thinking.

Creative Thinking, Critical Thinking

What is creative thinking? What is critical thinking? We often view these terms as opposites that are poles apart and incompatible. We stereotype the creative thinker as wild and zany, thriving on off-the-wall, impractical ideas; in contrast, we envision the critical thinker as serious, deep, analytical, and impersonal. Consider instead a different view—that these two ways of thinking are complementary and equally important. They need to work together in harmony to address perceived dilemmas, paradoxes, opportunities, challenges, or concerns (Treffinger, Isaksen, & Stead-Dorval, 2006).

Creative thinking involves searching for meaningful new connections by generating many unusual, original, and varied possibilities, as well as details that expand or enrich possibilities. Critical thinking, on the other hand, involves examining possibilities carefully, fairly, and constructively—focusing your thoughts and actions by organizing and analyzing possibilities, refining and developing the most promising possibilities, ranking or prioritizing options, and choosing certain options.

Generating many possibilities is not enough by itself to help you solve a problem. Similarly, if you rely on focusing alone, you may have too few possibilities from which to choose. Effective problem solvers must think both

creatively *and* critically, generating options *and* focusing their thinking.

Both generating and focusing involve learning and applying certain guidelines (attitudes and habits of mind that support effective thinking) and tools. Let's first look at the guidelines for generating and focusing, and then consider a number of specific tools.

Habits of the Mind for Generating Ideas

Individuals or groups use generating tools to produce many, varied, or unusual possibilities; to develop new and interesting combinations of possibilities; or to add detail to new possibilities. When using these tools, it is important to follow four broad guidelines, or ground rules (Treffinger, Isaksen, & Stead-Dorval, 2006):

- *Defer judgment*. When generating options, productive thinkers separate generating from judging. They direct their effort and energy to producing possibilities that can be judged later.
- *Seek quantity*. The more options a person or group generates, the greater the likelihood that at least some of those possibilities will be intriguing and potentially useful.
- *Encourage all possibilities*. Even possibilities that seem wild or silly might serve as a springboard for someone to make an original and powerful new connection.
- *Look for combinations*. It is often possible to increase the quantity and quality of options by building on the thinking of others or by seeing new combinations that may be stronger than any of their parts.

Brainstorming is probably the most widely known generating tool (but often the most misunderstood and misused tool, too). Many people use the term *brainstorming* as a synonym for a general conversation, discussion, or exchange of views. It is more accurate, however, to view brainstorming as a specific tool in which a person or a group follows the four guidelines described above to search for many possible responses to an open-ended task or question. As illustrated in Figure 1, there are also several other tools for generating options (Treffinger, Nassab, et al., 2006).

Habits of the Mind for Focusing Ideas

Focusing tools help individuals or groups analyze, organize, refine, develop, prioritize, evaluate, or select options from the set of possibilities they have at hand. When using these tools, problem solvers should again follow four broad guidelines or ground rules (Treffinger, Isaksen, & Stead-Dorval, 2006):

- *Use affirmative judgment*. When focusing their thinking, productive thinkers examine options carefully but constructively, placing more emphasis on screening, supporting, or selecting options than on criticizing them.
- *Be deliberate*. Effective focusing takes into consideration the purpose of focusing. Is it to select a single solution, to rank order or prioritize several options, to examine ideas carefully with very detailed criteria, to refine or strengthen options, or to create a sequence of steps or actions? Each of these purposes might be best served by a specific focusing tool.
- *Consider novelty*. If the stated goal is to find a novel or original solution or response, then it is important to focus deliberately on that dimension when evaluating possible solutions, and not simply to fall back on the easiest or most familiar options within a list.
- *Stay on course*. When focusing, it is important to keep the goals and purposes of the task clearly in sight and to ensure that you evaluate the options in relation to their relevance and importance for the goal.

The Problem Solver's Basic Toolbox

At the Center for Creative Learning, we have developed a Creative Problem Solver's Basic Toolbox of generating and focusing tools (see fig. 1 for the toolbox and links to examples of each tool).

Figure 1. The Creative Problem Solver's Basic Toolbox

Tools for Generating Possibilities (Creative Thinking)	Tools for Focusing Possibilities (Critical Thinking)
Brainstorming.Generating many, varied, or unusual options for an open-ended task or question.	**Hits and Hot Spots**. Selecting promising or intriguing possibilities (identifying hits) and clustering, categorizing, organizing, or compressing them in meaningful ways (finding hot spots).
Force-Fitting. Using two objects or words that seem unrelated to the task or problem, or to each other, to create new possibilities or connections.	**ALoU: Refining and Developing**. Using a deliberate, constructive approach to strengthening or improving options, by considering ***a****dvantages,* ***l****imitations* (and ways to ***o****vercome* them), and ***u****nique features*.
Attribute Listing. Using the core elements or attributes of a task or challenge as a springboard for generating novel directions or improvements.	**PCA: Paired Comparison Analysis**. Setting priorities or ranking options through a systematic analysis of all possible combinations.
SCAMPER. Applying a checklist of action words or phrases (idea-spurring questions) to evoke or trigger new or varied possibilities.	**Sequencing: SML**. Organizing and focusing options by considering **s**hort, **m**edium, or **l**ong-term actions.
Morphological Matrix. Identifying the key parameters of a task, generating possibilities for each parameter, and investigating possible combinations (mixing and matching).	**Evaluation Matrix**. Using specific criteria to systematically evaluate each of several options or possibilities to guide judgment and selection of options.
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Teachers can incorporate instruction in creative and critical thinking into the curriculum in a number of ways, either singly or in combination. I recommend that teachers follow several guidelines.

Introduce the tools directly, using engaging, open-ended questions from everyday life. Be clear that the purpose of such out-of-context work is to gain confidence and skill in using the tool, so everyone will be successful when using it in context.

Next, provide opportunities to apply the tools in lessons or activities related to specific content areas. Any of the generating and focusing tools can be used to help students master a variety of specific content standards in many areas (see Treffinger, 2007; Treffinger et al., 2004a, 2004b, 2004c).

Kopcak (2007), for example, describes using the Brainstorming, Hits and Hot Spots, and Paired Comparison Analysis tools with high school seniors as they worked on the Virginia learning standard "The student will write documented research papers." The students began with a stack of blank sticky notes on which they wrote possible topics (one per sticky note). After covering a chalkboard with sticky notes, the class paused to discuss the characteristics of a good research topic. The students used the Hits and Hot Spots focusing tool to select promising topics and organize them into categories based on theme or overarching topic; they used the Paired Comparison Analysis focusing tool to narrow down the most appealing options.

Other examples of applications of the tools in content areas include

- *Attribute Listing.* Understanding the important elements or parts of a topic being studied (for example, the major attributes of a country or civilization in social studies, the major elements of a story, or the characteristics of the main characters in a novel).
- *Brainstorming.* Identifying varied or unusual ways to make people aware of the importance of voting. Generating many possible math problems that could be constructed from a given set of data, events, or circumstances. Listing many ways to promote recycling or conservation.
- *Evaluation Matrix.* Evaluating choices or possible courses of action faced by people or groups in literature or social studies units (for example, in a film the students have viewed or a story they have read). Judging and choosing one of several possible themes, plots, or endings for a story or dramatic scene.
- *Sequencing: SML.* Investigating career preparation (for instance, "If you want to become a _____, the steps or stages in your preparation should include …"). Understanding and ordering the stages or chronology in an event or process (for example, the steps in an experiment or the sequence of certain measurements to be taken on a set of data).

Be deliberate about applying the basic tools in several different content areas, to help students learn how to transfer their learning about the tools across contexts. As you work with the tools, be explicit about metacognitive skills. Ask, "What is the tool? How did you use it? When and why would you use it in other situations?"

Beware of presenting too much newness at once. When you are working with new content, start with familiar tools. When you are introducing new tools, start with familiar content. Don't try to teach all the tools at once.

When students are comfortable with the basic generating and focusing tools, teachers may guide them in applying these tools through the Creative Problem Solving framework, a model for attaining clarity about tasks, defining problems in a constructive way, generating possible solutions, preparing for action and successful implementation of solutions, and dealing with change. For more information about the Creative Problem Solving framework, see the resources at the Center for Creative Learning.

It is also important to engage students in finding and solving real-life problems or challenges within the classroom, the school, or the community. Two widely known enrichment programs can provide engaging opportunities for students to apply creative problem solving.

Preparing Students for a Changing World

By helping students learn and apply the attitudes and practical tools of effective problem solvers, teachers can enhance student learning in powerful ways that extend beyond memorization and recall. Even when teachers are compelled to place great emphasis on basic learning and doing well on standardized tests—indeed, particularly at

such times—it remains important to balance the emphasis between process and content in teaching and learning. Students who are competent in not only the basics of content areas but also the basics of productive and creative thinking will be lifelong learners, knowledge creators, and problem solvers who can live and work effectively in a world of constant change.

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Examples of Basic Problem-Solving Tools

Unless otherwise noted, the following examples of each of the tools are adapted from Treffinger and Nassab (2005) or Treffinger et al. (2006).

Brainstorming

In a class that was preparing to study the countries of North America, the teacher posed the following task for the students to think about, using the Brainstorming tool: List many questions about the countries we will be studying. Try to list some questions that will help us look at the countries in a different way and some unusual or original questions.

In just 10 minutes, the class generated more than 60 questions. Some of the questions might be described as common (for example, Where is the country located? or What is its population?). Other questions were much more original (What are some controversial or highly debated issues in this country? or How has the country's economy been affected by digital technology in the last five years?). The teacher later categorized or clustered the students' questions into groups and used them as starting points for projects in which small groups of students sought information about particular countries and reported their findings.

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Force-Fitting

A group of students made Force-Fitting card decks by gluing pictures of everyday objects on large index cards (one picture per card). They used their Force-Fitting cards to generate some new and unusual ideas for improving the furniture in their classroom. They started by exploring ways to improve the room's straight, hard, metal and formed-plastic chairs. The students selected three cards randomly from their deck: a table lamp with a flexible, goose-neck frame; a fancy diamond necklace; and a telescope. Then, they used the three objects to think of new ways to improve their chairs. The telescope led them to consider making the chair's legs adjustable. The flexible lamp immediately led them to think about mounting a similar lamp on the top of the chair's back to provide a convenient and adjustable light source. They also stretched their thinking beyond this first, rather obvious connection and soon turned to the flexible neck of the lamp, which led them to consider modifying the back of the chair so that its position could be moved (from left to right, or from straight to a reclining position). The fancy diamond necklace made them think about decorating the outside of the chair's frame so that each student could personalize his or her own chair. This card also suggested creating a chair that was ornate and fancy and might even be elevated like a throne, which could be used to recognize certain students for special occasions or accomplishments. The students liked the idea of earning the right to use the "Diamond Chair" as a special privilege.

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Attribute Listing

Steve used the Attribute Listing tool to explore ways to improve how he presented his science project. He identified three key attributes or parts of his presentation—visual display, oral presentation, and written report. Then, he generated ways to improve or modify each of those parts. Below is Steve's list of possible changes for his task:

- *Visual Display*. Make larger, use a trifold out of cardboard, use bright colors, use computer to make written parts and drawings, add some charts and graphs, use some pictures or cartoons to get attention, include something that moves, use an overhead projector, add lights, add something people can touch or use.
- *Oral Presentation*. Use music in background, use sound effects, use Power Point, dress up in a lab coat, wear a necktie, use props.
- *Written Report*. Put in notebook, make colorful cover, do it on the computer, add some more graphs and charts, include some photographs, use color and highlight parts, use more labels, use more variety in the words, add a glossary of terms.

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SCAMPER

Using the acronym SCAMPER, students look for new possibilities by applying the following checklist of action words or phrases:

- S - Substitute
- C - Combine
- A - Adapt
- M - Magnify or Minify

- P - Put to other uses
- E - Eliminate
- R - Reverse or Rearrange

One group of students, working on a unit on inventions, chose to study the telephone. They used the SCAMPER tool to identify many, varied, and unusual ways the telephone might be modified and improved. Then, they searched through many stores and catalogs, located examples of modifications and extensions of the basic idea of the telephone, and considered what SCAMPER words and questions might have led to those modifications. For example, *combine* might have been used to create a telephone that also had a video screen. *Magnify* (or *make larger*) might have stimulated the thinking of the makers of a phone with giant touch-tone buttons on its keypad. *Minify* (or *make smaller*) might have paved the way for many of today's tiny cell phones. *Combine* or *put to other uses* might have led one clever group to a wristwatch that included a cell phone—and a TV remote! The students concluded their project by hypothesizing new changes and developments that might be produced in the future.

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Morphological Matrix

In one class studying the elements of character, the teacher provided the following Morphological Matrix:

	Who	Where	What	Why
1	Young Children	Home	Trustworthiness	Peace
2	Elementary Kids	School	Respect	Conflict
3	Middle School	Mall	Responsibility	Order
4	High School	Office	Fairness	Calm
5	College	Internet	Citizenship	Anger
6	Parents	Church	Caring	Flow
7	Teachers	Cafeteria	Participation	Verbal Communication
8	School Staff	Business	Preparation	Writing
9	Business Folks	Media	Promptness	Listening
0	Police	Travel	Love	Nonverbal Communication

The teacher asked students to use the last four digits of their phone numbers to randomly obtain one item from each column. Students then combined the four items to create sentences describing how the basic

elements of character are used in everyday life.

For example, the four digits 5881 yielded the following items: *college, business, prepared,* and *peace.* The students combined these items to produce the sentence,

> *Most college students are preparing to enter business fields and want to find peace within their lives.*

The four digits 4352 yielded the items high school, mall, citizenship, and conflict. The students combined these items to produce the sentence,

> *When high school students exhibit good citizenship they will not encounter conflict in the mall.*

Students developed the sentences individually and then worked in pairs to combine their sentences or to choose the best one for a presentation to the whole class. Later, they wrote reflections on the activity.

(Example contributed by Jennine Jackson, Teacher of the Gifted, Amphitheater School District, Tucson, Arizona, and Affiliate Director of the Arizona Future Problem Solving Program International)

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Hits and Hot Spots

In a high school science class, the students worked on designing appropriate zoo habitats for several endangered species. The students selected an animal, conducted research on the animal, and then generated lists of questions they had about the animal and its habitat. They used Hits and Hot Spots to identify the most important questions and to identify four major clusters to guide their subsequent research and planning.

Another class used the Hits and Hot Spots tool to plan a school party. First, they used generating tools to come up with a list of more than 80 possibilities. Using the Hits and Hot Spots tool, they grouped (or clustered) their Hits into the following five Hot Spots: Activities, Refreshments, Place, Time, and Cost. They decided to host an after-school party in the cafeteria. They could afford soda and popcorn. Dancing was the favorite activity. Several students volunteered to bring in their CDs and supply the music.

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ALoU: Refining and Developing

One group of students generated ideas on how to improve communication between the deaf and the hearing members of the school community. The group decided to take a closer look at one of the ideas: *Show a 'word-of-the-day' in sign language during the morning TV announcements. Ask teachers and students to use it.* They used the ALoU (**A**dvantages, **L**imitations [and ways to **o**vercome them], and **U**nique features) tool to improve and strengthen this idea. Their work is shown below.

Advantages

- Easy to manage and do within our time limits
- Fun for everyone
- People would actually be learning sign language a little at a time
- Seeing and using sign language would become more accepted in school
- No cost involved

- Very visible

Limitations (and how to overcome them)

- *How to ensure that it would get used?*
  - Let teachers know the words ahead of time so they can include ways to use them in daily/weekly plans.
  - Make it a contest, like a spelling bee each month.
- *How to get participants to take it seriously?*
  - Do a "hush day" to help people get a firsthand understanding of the need for all to communicate.
  - Bring in or create a school presentation using words and sign language to demonstrate the importance of diversity.

Unique Features

- Our deaf population might be able to communicate with all others in the school without the need for an interpreter.
- Sign language might be seen as a language just like other foreign languages and be taught as a subject.

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PCA: Paired Comparison Analysis

The PCA tool can be used whenever students have a set of appealing options to rank or prioritize. One class used the PCA tool to help decide which of several possible field trips they preferred to take, knowing that time and budget limitations might make only one field trip possible for the group that year. Five options were generally appealing to many of the class members: the zoo, a concert by the local symphony orchestra, the nearby Inventor's Hall of Fame and Invention Center, a local newspaper office, and a theme park.

The class discussed several important criteria to consider in evaluating the options, including cost, time required, personal appeal and interest, relating the trip to other class activities and studies, learning value, and possibility of students visiting the site at another time with friends, family, or other groups. Each student in the class then completed a PCA sheet. The trip to the hall of fame/invention center was the highest ranking option, followed by the concert and the trip to the newspaper office.

The students prepared a proposal about their choices and were rewarded by winning approval for trips to both the invention center *and* the symphony concert!

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Sequencing: SML

A group of middle school students decided to plan and conduct a campaign in their school to make students aware of the importance of community service by young people. They wanted to build interest by sharing information about a particular service project in their community for which the students could volunteer. They used the Sequencing (SML) tool to arrange a number of possible action steps in a workable and appropriate order.

- In the short term (and before they contacted any other agencies or the student body), the students needed to understand community service better themselves. They listed questions to ask representatives from one or more community agencies.
  Next, they researched agencies in their community that needed volunteers and would be receptive to middle school students as well as interesting to the students.
- As a medium-range step, the group prepared and rehearsed the kind of interview they would do with representatives from the agencies, contacted one agency, conducted their interviews, and began doing some volunteer work themselves.
- The students' long-term steps involved creating an appealing presentation that incorporated information from their interviews and personal experiences to inform other students and to stimulate their involvement.

The presentation was highly successful, and more than 25 other students in the school became involved in volunteer work in the community.

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Evaluation Matrix

Cindy's grandmother lives alone in an apartment. She wanted a pet. The family decided to buy her a dog. However, there were rules about having pets in the apartment building. Also, Grandma didn't have a lot of money to spend on a pet. The family selected the five dogs that they wanted to consider, and writing the name of each breed dog in each row of the matrix under the *options* column heading. Thinking about Grandma and where she lived, the family decided to use the following criteria:

- Which dog can Grandma best afford?
- Which dog will be the most quiet?
- Which dog will be the easiest for Grandma to care for by herself (walk, bathe, groom, and so on)?
- Which dog will be protective when needed?
- Which dog will be the friendliest companion to grandma?

The family wrote a word or phrase to represent each criterion as column headings in the matrix. They decided to use a 1–5 rating scale, with 1 as the lowest rating and 5 as the highest rating. They evaluated each option against each criterion and totaled the ratings for each option. They looked at the results and noticed that there was little difference among the ratings of the dogs. Each dog had strengths and weaknesses. After talking to Grandma, the family decided to get her a Lab, a quiet and friendly dog.

Options for Breeds	Fits Gram's budget	Most quiet	Ease of care	Protectiveness	Friendliness	Total
Labrador retriever	3	5	3	2	5	18
Toy poodle	3	2	3	3	4	15

Pit bull	4	2	3	5	1	15
Siberian husky	3	3	2	3	3	14
Jack Russell terrier	3	2	4	3	2	14

In another setting, a group of students used the Evaluation Matrix as a tool to help them select books to check out from the library. Some of the criteria they considered included the relevance of the theme or topic to personal interests, usefulness for preparing a report (related to a class assignment), length of book, size of print, number of illustrations, quality of illustrations, and difficulty of the book. With these criteria and an Evaluation Matrix Worksheet, the students went to the library, browsed for a while, selected several possible books to check out, and then used the Evaluation Matrix to help focus their choices. Later, after completing their reading, they discussed how they used the tool and considered the extent to which it helped them make a good choice. Most students found that it was a helpful tool that they would use again when choosing among many possibilities.

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Enrichment Programs That Foster Creativity and Problem Solving

Future Problem Solving Program

Future Problem Solving Program International (FPSPI) is a nonprofit educational corporation administering creative problem-solving activities for students in grades K-12. More than 250,000 students in several countries participate annually in competitive and noncompetitive activities in creative problem-solving. Students or teams may participate in the junior division (grades 4–6); the middle division (grades 7–9); or the senior division (grades 10–12). FPSPI selects five topics each year, and students participate in team problem solving, community problem solving, or scenario writing. The topics for 2008–09 are *Olympic Games, cyber conflict, space junk, counterfeit economy,* and *pandemic*.

Destination ImagiNation

The Destination ImagiNation flagship program is a process-based program that helps young people build lifelong skills in creative and critical thinking, teamwork, time management, and problem solving. Up to seven participants work together as a team for 8–12 weeks to create their solution to a team challenge, which can have a theatrical, structural, improvisational, scientific, or technical focus. Teams also learn and practice quick-thinking skills for the Instant Challenge portion of the program.

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