Problem Solving

Rocky View's view of the future

Teaching and learning in the 21st Century is inherently complex and dynamic. Gone are the days when the teacher was the "source of knowledge" and the student the "receiver of knowledge". Given that the digital age will see technical information double every 72 hours by the year 2010, it will be impossible for educators to even know what knowledge will be needed for the students of today to thrive tomorrow.

Portrait of a 21st Century Learner

a critical thinker
a problem solver
an innovator
a communicator
a collaborator
globally aware
civically engaged
a self-directed learner
information & media literate
financially & economically literate

To succeed in our global community, I will need to be...

Based on this reality, the challenge for today's educator is to help students "continually learn and apply new knowledge to complex, novel, open-ended challenges" (Treffinger in press). In short, educators need to teach students to "think".

Rocky View Schools' second edition of Portrait of a 21st Century Learner focuses on a fundamental thinking tool and the Portrait's second charactertistic, "problem-solving".

Understanding problem-solving

Regardless of the classroom setting, whether it is a Grade 10 math class, a Grade 4 language arts class, or a middle school science club, education engages students in problem-solving exercises. The Grade 10 math class, for example, will answer the question, "What does 'x' equal?" The Grade 4 language arts students studying the connection among a novel's plot, setting and characters will explore the question, "What does this mean?". And members of the science club most likely are finding answers to the question "Why and how does this happen?"

Educators know lessons plans that concentrate on facts and procedures result in students who learn to memorize materials. On the other hand, lessons based on students grappling with a problem and making their own connections results in students who fully understand and are able to use the information before them. But is focused inquiry enough?

The Centre for Creative Learning states that although educators routinely teach students to problem-solve through techniques such as looking for patterns, constructing a table or making an organized list, in preparing students to systematically resolve real-life challenges in our changing society, educators must empower students to become both creative and critical thinkers. The Centre defines creative thinking as the process of searching for "meaningful new connections by generating many unusual, original and varied possibilities, as well as details that expand or enrich possibilities". As presented in RVS' first edition of Portrait of a 21st Century Learner on Critical Thinking, this quality of thinking involved examining possibilities carefully, fairly and constructively. By definition, critical thinking asks students to focus their thoughts and actions to secure responses that are supported by evidence, give consideration to alternate points of view, and stand on firm belief.

Empowering students to become both creative and critical thinkers begins when they are encouraged to explore problems with their peers, rather than through their teacher. When given independence to build from their own creativity, students begin to initiate and manage their own learning tasks. An educator's role in this process is to act as a guide by helping students learn how to manage the information needed to solve a problem.
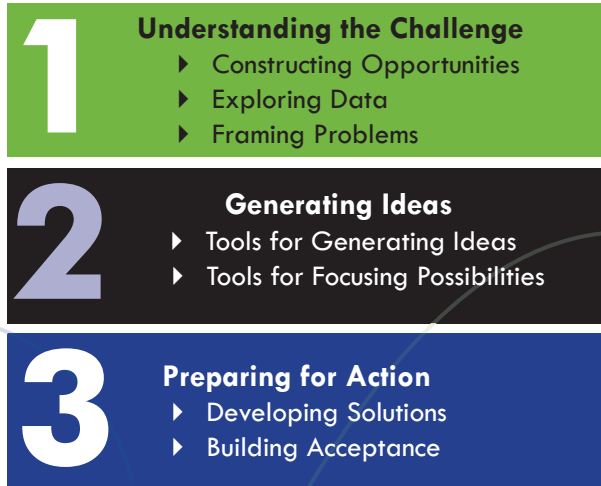
engage enrich empower

Creative problem - solving framework

In helping students to become effective problem-solvers, the Centre for Creative Learning offers a "Creative Problem-Solving Framework" that uses both creative and critical thinking skills in harmony:

Fig. 1. Creative Problem-Solving Framework (Excerpt)

1 Understanding the Challenge
- ▸ Constructing Opportunities
- ▸ Exploring Data
- ▸ Framing Problems

2 Generating Ideas
- ▸ Tools for Generating Ideas
- ▸ Tools for Focusing Possibilities

3 Preparing for Action
- ▸ Developing Solutions
- ▸ Building Acceptance

(Centre for Creative Learning <www.creativelearning.com>2005)

Understanding the challenge

For students to move forward with confidence and enthusiasm, they must understand the challenge. This involves engaging students in clarifying, formulating or focusing their thinking. The Centre for Creative Learning promotes the use of one or more stages:

Constructing Opportunities - Ask students to state broad, brief, and beneficial opportunities and challenges before identifying and clarifying a constructive goal to pursue.

Exploring Data - Ask students to consider what they know about the situation and what they need to know, before focusing on the most important elements of the task or situation.

Framing Problems - Encourage students to think about "How might we..." rather than "We can't because..."by generating many, varied, and unusual ways to pose the problem.

Generating ideas

Generating ideas is not enough in itself to help solve a problem. Similarly, focusing may lead to too few possibilities from which to choose. Drawing on both creative and critical thinking skills, students who are effective problem-solvers generate options and focus their thinking. Tools to help students master these skills are:

Fig. 2 The Problem-Solver's Basic Toolbox

Tools for Generating Possibilities	Tools for Focusing Possibilities
Brainstorming. Generating many, varied or unusual options for an open-ended task or question.	**Hits and Hot Spots.** Selecting promising and 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.** Using a deliberate, constructive approach to strengthening or improving options, by considering Advantages, Limitations, and Unique features.
Attribute Listing. Using the core elements or attributes of a task or challenge as a springboard for generating novel directions or improvements.	**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.** Organizing and focusing options by considering short, medium or long-term actions.
Morphological Matrix. Identifying the key parameters of a task, generating possibilities for each parameter, and investigating possible combinations (mixing and matching).	**Evaluation.** Using specific criteria to systematically evaluate each of several options or possibilities to guide judgment and selection of options.

(Preparing Creative and Critical Thinkers: Educational Leadership Summer 2008)

Preparing for action

Lastly, the Centre's framework asks students to "prepare for action" by exploring ways to make promising options into workable solutions and preparing for successful implementation. Two components to consider include:

Developing Solutions - Encourage students to identify strategies and tools that will help analyze, develop and refine the possible solution.

Building Acceptance - Ask students to consider ways to build support and to decrease resistance to their possible solution.

Words of advice

Effective implementation of this framework begins with the use of engaging, open-ended questions relevant to everyday life. Teachers need to appeal to students' natural instincts to investigate and create by linking Alberta Education's Programs of Study to what interests and engages students. In 1923, educational reformer John Dewey wrote:

> Methods which are permanently successful in formal education . . . go back to the type of situation which causes reflection out of school in ordinary life. They give pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results.

More than 80 years later, students still learn best by doing and by thinking through problems. Educators need to recognize that in preparing students for the world outside of school, they must be prepared to build their knowledge and skills as do adults, by solving real problems and answers to important questions—not through abstract or textbook exercises.

Indicators of creative and critical thinkers

Educational researchers such as the Metiri Group believe creative and critical thinkers need to possess five inherent qualities:

- **Adaptability** - The ability to modify one's thinking, attitude, or behaviour to be better suited to current or future environments.
- **Self-directedness** - The ability to set goals related to learning, plan for the achievement of those goals, independently manage time and effort, and independently assess the quality of learning.
- **Risk-taking** - The willingness to make mistakes, advocate unconventional or unpopular positions or tackle extremely challenging problems without obvious solutions.
- **Curiosity** - The desire to know or a spark of interest that leads to inquiry.
- **Creativity** - The act of bringing something into existence that is new and original.

Researchers believe that only when these problem-solving characteristics are apparent will students: think about problems from multiple perspectives; understand problems can be solved using different strategies and can involve more than one solution; strive towards goals despite obstacles; manage multiple goals; be self-directed in relation to managing time and resources.

Assessing students' progress

In evaluating students' progress towards becoming effective problem solvers in the 21st Century, the Metiri Group judges students on a continuum of learning. The following figure illustrates how two characteristics, adaptability and self-directedness, can be evaluated making use of a rubric:

Fig. 3 Continuum of Progress

	Novice	Proficient
Adaptability	• relies on old techniques and resists learning to use tools	• discards old techniques in favour of new ones, and actively looks for innovations
Self Directed	• directs own learning agenda; actively tries to improve; critiques resources.	• depends upon others for learning agenda; covers up mistakes; rarely critiques.

(Engage 21st Century Skills <http://www.metiri.com/> 2008)

The connection between home and school

In many situations, students will solve problems intuitively, meaning they will arrive at a decision based on prior knowledge and reasoning. To broaden their child's creative and critical thinking skills, parents can reinforce the work of teachers by emphasizing problem solving as the process of acquiring new knowledge based on a recognition of a need to learn.

Below are a few ideas the Critical Thinking Consortium offers to parents to help children develop their problem-solving skills.

Encourage deliberation. When helping with homework, encourage your child to suggest his/her own ideas and to explain why. When correcting errors, rather than simply telling the right answer, guide your child by asking open-ended questions (e.g., Have you thought about the effects of . . ? What else might happen if you did this? That sounds interesting, can you tell me why you thought this?).

Reward creative thinking. Praise imaginative or thoughtfully supported ideas, even if the comments are not entirely correct.

Approach every day as a day to explore. Look for casual opportunities, especially while reading books, to raise questions that require assessing various alternatives (e.g., Do you think it would have been better for the character to do ... or ... ?).

Encourage all possibilities. Encourage your child to explore positions from different points of view, especially from perspectives that he/she does not personally hold (e.g., How might your brother feel about . . . .? I know you don't like having to do it, but why might your teacher think that homework is important?).

Use affirmative judgment. Help your child identify the relevant factors or criteria to consider when making a particular decision (e.g., When selecting a bicycle children might consider the cost; how often they will use it; whether it suits their needs). Place more emphasis on screening, supporting or selecting options than on criticizing them.

Work at it every day. Invite and (when appropriate) accept your child's ideas and suggestions in planning events, establishing family rules and in solving personal problems.

(Adopted from "Nurturing critical thinking: a note to parents" The Critical Thinking Consortium <www.tc2.ca> 2008)

Suggested reading

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For more information

For further resources on Rocky View Schools approach to Problem Solving contact