Fostering Problem Solving with Critical Thinking

Ontario Teachers' Federation

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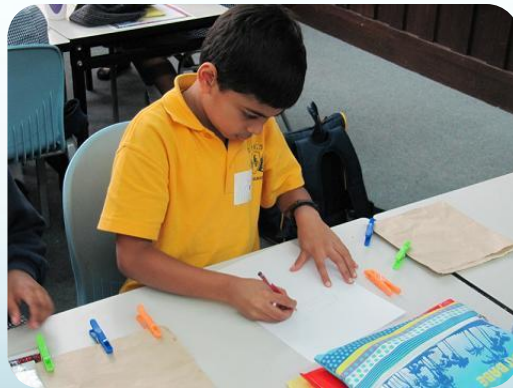
The Critical Thinking Consortium

What's the Big Idea?

❖**Critical inquiry opens up new ways to engage students in productive and rigorous thinking about mathematics.**

A person is thinking critically if he or she is **judging** or making choices among **options** in light of **criteria**.

- *"In a fixed **mindset**, people believe their basic qualities, like their intelligence or talent, are simply fixed traits."*

- *"In a **growth mindset**, people believe that their most basic abilities can be developed through dedication and hard work—brains and talent are just the starting point."*

- From: Carol Dweck, mindsetonline.com

In the growth mindset:

"When [successful students] experience a setback, they focus on effort and strategies instead of worrying that they are incompetent."*

"We have to spend a lot more time teaching strategies."

- John Hattie,

Visible Learning for Teachers: Maximizing Impact on Learning

So…why infuse mathematics with critical thinking?

- Critical thinking emphasizes the idea that **math requires thinking for yourself.**

- We can help students develop **meta-cognitive and self-regulation skills** that support learning.

- We have **more options for adapting instruction** to meet the needs of students.

By infusing our teaching with critical thinking, we can help students …

learn to think

and

think to learn.

Creating a thinking classroom

Nurture thoughtful communities

Frame critical challenges

Teach the intellectual tools

Assess thinking and performance

Background knowledge

Criteria for judgment

bias

Critical thinking vocabulary

Thinking srategies

Habits of mind

With TC^2 critical challenge types:

- Decide if a solution strategy is effective.

- Choose between two strategies – which is more effective?

- Adapt a strategy to make it more effective.

- How does this solution strategy work?

- Create an effective solution strategy.

Critique the piece

Judge better or best

Rework the piece

Decode the puzzle

Design to specs

Introducing…. Math Question Frames

- Decide if a solution strategy is effective.

- Choose between two strategies – which is more effective?

- Adapt a strategy to make it more effective.

- How does this solution strategy work?

- Create an effective solution strategy.

- **Is this an effective _____ ?**

- **Which of these _____ is more effective?**

- **What would happen if _____?**

- **How does this _____ work?**

- **How would you figure out _____?**

Criteria for an effective mathematical drawing

From *Adding it Up*

(referring to all representation strategies)

- Transparency
- Efficiency
- Generality
- Clarity
- Precision

From a Grade 4 class:

- Matches the math in the problem (or situation)
- Helps me understand
- Leads to a reasonable answer
- Doesn't take too long

National Research Council (2001) Washington, DC: National Academy Press.

Possible criteria for an effective problem solving strategy:

- produces a reasonable answer

- makes good use of time and effort

- suits the numbers and situation

- supports understanding

Which counting strategy **is most effective?**

Counting by ones.	Making piles of 4.	Making piles of 10.

Possible Criteria:
- Reasonable: *It gives me the right number.*
- Efficient: *It doesn't take too long.*
- Well understood: *I understand what I am doing.*
- Easy to check: *I can go back and check my total.*

Snack Bars
5 for $12

Which is the better deal?

Snack Bars
10 for $25

Which rate comparing **strategy is more effective in this situation?**

Find the unit rate.

Scale up or down.

Possible Criteria:
- Reasonable
- Efficient
- Builds understanding

How would you figure out _____?

What are the best fruits to include in our Friday lunch program?

How much paper will our class use during the school year?

How many hockey pucks would it take to fill our classroom?

Suggested criteria for a useful plan:
- It will give a reasonable answer
- We can carry it out.

"Does your solution make sense?"

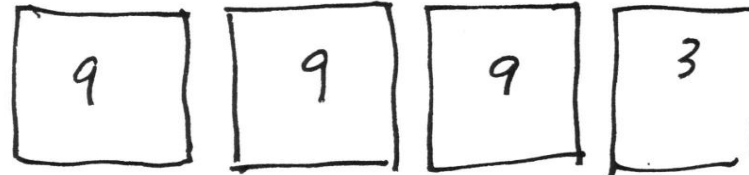- What are the criteria for a solution that makes sense?

Possibly:

- answers the question

- fits with information in the problem

- fits with what I already know about mathematics and the world

Draw a picture or diagram

Manuel collects baseball cards. He keeps them in plastic pages with pockets. Each page holds 9 cards. One day, Manuel buys 30 new cards. How many plastic pages will Manuel need to hold all of his new cards?

Which of the drawings is most effective for solving this problem?

Sample drawing or diagram	Criteria for effectiveness
A.	❏ Matches the problem mathematically ❏ Builds understanding ❏ Gives a reasonable answer ❏ Doesn't take too long
B.	❏ Matches the problem mathematically ❏ Builds understanding ❏ Gives a reasonable answer ❏ Doesn't take too long
C.	❏ Matches the problem mathematically ❏ Builds understanding ❏ Gives a reasonable answer ❏ Doesn't take too long

I chose drawing ____. I chose it because

Some students' responses:

A. I chose B because *it can help you because it doesn't take too long to figure out and it tells you how many are in a page.*

B. I chose drawing C because *it has tallies and they are easier to figure out.*

C. I chose drawing C because *it is really easy to see it and find out the answer.*

D. I chose drawing B because *it matches the problem mathematically, builds understanding, gives a reasonable answer and doesn't take too long.*

Thank you for participating!

I would love to hear your comments and questions.

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