

CRITICAL THINKING—What is it exactly?

No one always acts purely objectively and rationally. We connive for selfish interests. We gossip, boast, exaggerate, and equivocate. It is "only human" to wish to validate our prior knowledge, to vindicate our prior decisions, or to sustain our earlier beliefs. In the process of satisfying our ego, however, we can often deny ourselves intellectual growth and opportunity. We may not always want to apply critical thinking skills, but we should have those skills available to be employed when needed.

Critical thinking includes a complex combination of skills. Among the main characteristics are the following:

Rationality

We are thinking critically when we

- rely on reason rather than emotion,
- require evidence, ignore no known evidence, and follow evidence where it leads, and
- are concerned more with finding the best explanation than being right analyzing apparent confusion and asking questions.

Math

Problem-Based Learning (PBL) The best strategy in PBL is presenting students with real life problems that require applications of math to solve or find a solution.

Students:

- determine what they know by identifying what is known, what needs to be found out, what they want to learn (KWL) based on a given case study scenario.
- develop a problem statement which contains steps for solving the problem and factors for determining successful completion.
- gather information through online resources, surveys, interviews, observations, measurements, etc.

- develop possible solutions using concept maps, Venn diagrams, graphic organizers, etc.
- present a solution to the case study based on what was learned.

Interactive Math Tools

The use of online interactive learning tools in math for solving and creating math problems is essential for allowing students to make connections in math. Choose an interactive tool that requires students to use problem solving strategies that use formal operational skills and proportional reasoning. The best interactive math tools require students to solve problems by applying more than one concept. Interactive math addresses the issue of engaging students through the use of virtual manipulatives to help them visualize math relationships. Virtual math learning en-

vironments allow students to apply logic and reasoning for problem solving.

Using Manipulatives

Learning and understanding mathematics, at every level, requires student engagement. Mathematics is not a spectator sport. Students must be engaged in the learning process through practical applications of math. Whether the manipulatives are purchased in kits or created from available materials, this hands-on learning approach engages students' minds as they use manipulatives to create models and representations to solve math problems.

Explain in Writing

This technique involves students solving a problem and then writing a story describing how the problem was solved. Writing provides students with a creative method to think and in-

ternalize how they linked math concepts in real life problem solving situations. These student writings also provide teachers with an insight into a student's true understanding of math that a dozen work sheets could never provide.

Making Connections

When students are engaged in learning math that is personal to them, they are engaged in the learning process. Problem solving situations, case studies, and traditional math problems focused on students provide increased opportunities to internalize and make connections. Students like to participate and not watch demonstrations of how to solve problems; true understanding comes from hands-on, minds-on math.



Essential Questions

Good essential questions have some basic criteria in common:

- They are open-ended and resist a simple or single right answer
- They are deliberately thought-provoking, counterintuitive, and/or controversial
- They require students to draw upon content knowledge and personal experience
- They can be revisited throughout the unit to engage students in evolving dialogue and debate
- They lead to other essential questions posed by students

The greatest novels, the greatest plays, the greatest songs and the greatest paintings all explore essential questions in some manner. Essential questions are at the heart of a search for Truth. Many believe that schools should devote more time to essential questions and less time to Trivial Pursuit.

English / Language Arts

Reading comprehension requires motivation, mental frameworks for holding ideas, concentration & thinking.

Here are some suggestions:

Develop a broad background.

Broaden your background knowledge by reading newspapers, magazines and books. Become interested in world events.

Identify the type of reasoning.

Does the author use cause and effect reasoning, hypothesis, model building, induction or deduction, systems thinking?

Anticipate and predict.

Really smart readers try to anticipate the author and predict future ideas and questions. If you're right, this reinforces your understanding. If you're wrong, you make adjustments quicker.

Create motivation and interest.

Preview material, ask questions, discuss ideas with classmates. The stronger your interest, the greater your comprehension.

Pay attention to supporting cues.

Study pictures, graphs and headings. Read the first and last paragraph in a chapter, or the first sentence in each section.

Highlight, summarize and review.

Just reading a book once is not enough. To develop a deeper understanding, you have to highlight, summarize and review important ideas. (Opportunity to use Digital Tools!)

Build a good vocabulary.

Use a reading technique like SQ3R.

Develop a systematic reading style, like the SQ3R method and make adjustments to it, depending on priorities and purpose.

Monitor effectiveness.

Good readers monitor their attention, concentra-

tion and effectiveness. They quickly recognize if they've missed an idea and backup to reread it.

Good readers make connections to text previously read, their own experiences, and world events, as well as examine critically in the context of critical lenses.



Science

When students are doing inquiry based science, an observer will see that:

Children View Themselves as Scientists

1. They look forward to doing science.
2. They demonstrate a desire to learn more.
3. They seek to collaborate and work cooperatively with their peers.
4. They are confident in doing science; they demonstrate a willingness to modify ideas, take risks, and display healthy skepticism.

Children Readily Engage in The Exploration Process.

1. Children exhibit curiosity and ponder observations.
2. They move around selecting and using the materials they need.
3. They take the opportunity and the time to "try

out" their own ideas.

Children Plan and Carry Out Investigations.

1. Children design a way to try out their ideas, not expecting to be told what to do.
2. They plan ways to verify, extend or discard ideas.
3. They carry out investigations by: handling materials, observing, measuring, and recording data.

Children Communicate Using a Variety of Methods.

1. Children express ideas in a variety of ways: journals, reporting out, drawing, graphing, charting, etc.
2. They listen, speak and write about science with parents, teachers and peers.
3. They use the language of the processes of science.
4. They communicate their level of understanding of concepts that they have developed to date.

Children Propose Explanations and Solutions.

1. Children offer explanations from a "store" of previous knowledge. (Alternative Frameworks, Gut Dynamics).
2. They use investigations to satisfy their own questions.
3. They sort out information and determine importance.
4. They are willing to revise explanations as they gain new knowledge.

Children Raise Questions

1. Children ask questions (verbally or through actions).
2. They use questions to lead them to investigations that generate further questions or ideas.
3. Children value and enjoy asking questions as an important part of science.

Children Use Observation.

1. Children observe, as opposed to just looking.
2. They see details, they detect sequences and events; they notice change, similarities and differences, etc.
3. They make connections to previously held ideas.

Children Critique Their Science Practices.

1. They use indicators to assess their own work
2. They report their strengths and weaknesses.
3. They reflect with their peers.

Content Specific Tips

SKILLS RELATED TO CRITICAL THINKING

Across subject areas and levels, educational research has identified several discrete skills related to an overall ability for critical thinking. **These are:**

- Finding analogies and other kinds of relationships between pieces of information
- Determining the relevance and validity of information that could be used for structuring and solving problems
- Finding and evaluating solutions or alternative ways of treating problems

Just as there are similarities among the definitions of critical thinking across subject areas and levels, there are several generally recognized "hallmarks" of teaching for critical thinking (see, for example, Beyer, 1985; Costa, 1985).

These include:

- Promoting interaction among students as they learn - Learning in a group setting often helps each member achieve more.
- Asking open-ended questions that do not assume the "one right answer" - Critical thinking is often exemplified best when the problems are inherently ill-defined and do not have a "right" answer. Open-ended questions also encourage students to think and respond creatively, without fear of giving the "wrong" answer.

- Allowing sufficient time for students to reflect on the questions asked or problems posed - Critical thinking seldom involves snap judgments; therefore, posing questions and allowing adequate time before soliciting responses helps students understand that they are expected to deliberate and to ponder, and that the immediate response is not always the best response.
- Teaching for transfer - The skills for critical thinking should "travel well." They generally will do so only if teachers provide opportunities for students to see how a newly acquired skill can apply to other situations and to the student's own experience.



Social Studies

* **Relate events in time.** Create chronological time lines of major events. Continually update time lines with new units of study. Refer to these time lines often for visual reinforcement.

* **Outline main ideas to highlight key information** and concepts. Assign outlining exercises with reading selections. Pare down textbook information through concise listings.

* **Distinguish between fact and opinion.** Provide students with opportunities to pre-

sent and defend personal viewpoints. Debate issues to foster healthy skepticism. Explain why specific answers are correct. Re-teach incorrect answers.

* **Recognize bias.** Discuss political cartoons from historical and personal perspectives. Explore and analyze advertisements and media coverage of political issues. Identify key terms that indicate opinion versus fact.

* **Make comparisons and correlations.** Relate historical events to more contemporary events to promote recall. Connect information to personal experiences. Use graphic organizers to visually represent relationships.

* **Identify cause-and-effect relationships.** Create tables to analyze consequences of events and actions. Use graphic organizers to visually represent cause and effect.

* **Draw conclusions.** Ask questions to summarize information. Apply information to new and different issues.

* **Recognize the contributions of others.** Identify personality traits of individuals who have shaped history. Ask students to assume the identity of significant historical figures to appreciate their sacrifices, dedication, and loyalty. Connect lives of others to personal experiences.

* **Express problems verbally.** Use brainstorming to encourage diverse responses. Practice open-ended questions. Encourage students to explain and/or defend answers.

* **Incorporate all levels of thinking into daily activities,** assignments, discussions, and homework. Carefully integrate categories of recall, analysis, comparison, reference, and evaluation. Provide opportunities to demonstrate learning. Offer daily practice in interpretation and application.

Self-awareness

We are thinking critically when we

- Weigh the influences of motives and bias, and
- Recognize our own assumptions, prejudices, biases, or point of view.

Honesty

We are thinking critically when we recognize emotional impulses, selfish motives, nefarious purposes, or other modes of self-deception.

Open-mindedness

We are thinking critically when we

- evaluate all reasonable inferences
- consider a variety of possible viewpoints or perspectives,
- remain open to alternative interpretations
- accept a new explanation, model, or paradigm because it explains the evidence

better, is simpler, or has fewer inconsistencies or covers more data

- accept new priorities in response to a reevaluation of the evidence or reassessment of our real interests, and
- do not reject unpopular views out of hand.

Discipline

We are thinking critically when we

- are precise, meticulous, comprehensive, and exhaustive
- resist manipulation and irrational appeals, and
- avoid snap judgments.

Judgment

We are thinking critically when we

- recognize the relevance and/or merit of alternative assumptions and perspectives
- recognize the extent and weight of evi-

dence

In sum,

• Critical thinkers are by nature skeptical. They approach texts with the same skepticism and suspicion as they approach spoken remarks.

• Critical thinkers are active, not passive. They ask questions and analyze. They consciously apply tactics and strategies to uncover meaning or assure their understanding.

• Critical thinkers do not take an egotistical view of the world. They are open to new ideas and perspectives. They are willing to challenge their beliefs and investigate competing evidence.

Critical thinking enables us to recognize a wide range of subjective analyses of otherwise objective data, and to evaluate how well each analysis might meet our needs.

Facts may be facts, but how we interpret them may vary.

By contrast, passive, non-critical thinkers take a simplistic view of the world.

• They see things in black and white, as either-or, rather than recognizing a variety of possible understanding.

• They see questions as yes or no with no subtleties.

• They fail to see linkages and complexities.

• They fail to recognize related elements.

Non-critical thinkers take an egotistical view of the world

• They take *their* facts as the only relevant ones.

• They take *their own* perspective as the only sensible one.

• They take *their goal* as the only valid one.

What Is It?

The Problem Solving process

consists of a sequence of sections which fit together depending on the type of problem to be solved.

These are:

- Problem Definition.
- Problem Analysis.
- Generating possible Solutions
- Analyzing the Solutions.
- Selecting the best Solution(s).
- Planning the next course of action (Next Steps)

REFLECTION:

Reflect ON ACTION

- Take a look at what you've done in the past.

Reflect IN ACTION

- Processing and thinking "in the moment."

Reflect FOR ACTION

- Look ahead. What have I learned? What's next?

Robert Marzano's Dimensions of Thinking

Knowing: Identifying and recalling information (list, name, label, recall, identify, match, choose)

Organizing: Arranging information to be used effectively (categorize, group, classify, compare, contrast)

Applying: Using information for practical purposes (apply, make, show, record, construct, demonstrate, illustrate)

Analyzing: Clarifying information by examining parts and relationships (outline, diagram, differentiate, analyze)

Generating: Producing new information, meaning, or ideas (conclude, predict, explain, elaborate, infer)

Integrating: Connecting and combining information (combine, summarize, design, imagine, generalize)

Evaluating: Assessing the reasonableness and quality of ideas (judge, evaluate, rate, verify, assess, define criteria)

Cognition

Sequencing
Identifying main idea and supporting details
Summarizing

Interpretation

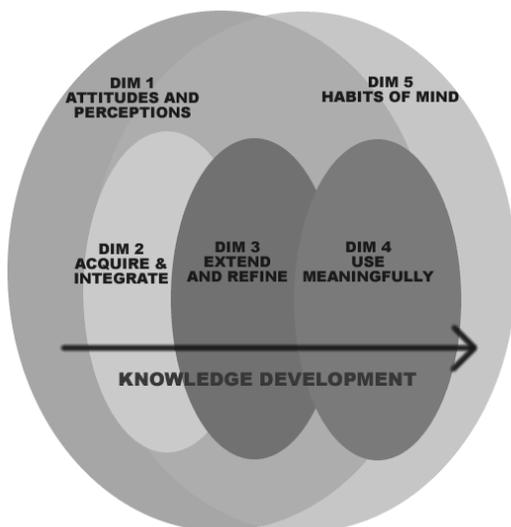
Making inferences
Drawing conclusions
Making predictions

Critical Stance

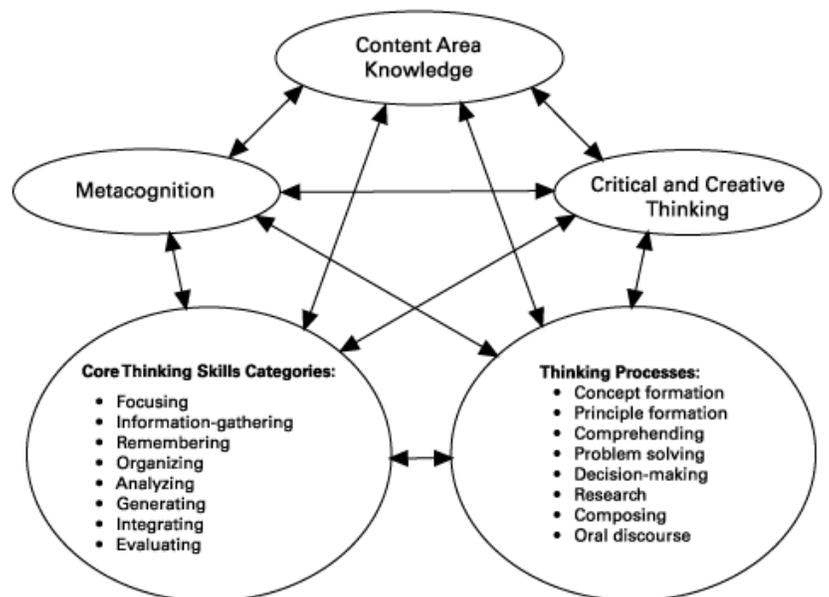
Evaluating author's craft and literary elements
Evaluating point of view
Comparing and contrasting

Connections

Text to Self
Text to Text
Text to World



Dimensions of Thinking*



Comprehension Strategies

Resources and Bibliography:

- <http://pareonline.net/getvn.asp?v=4&n=3>
- http://continuingeducation.suite101.com/article.cfm/math_teaching_strategies_that_challenge_students
- "Inquiry Based Science: What Does It Look Like?" Connect Magazine

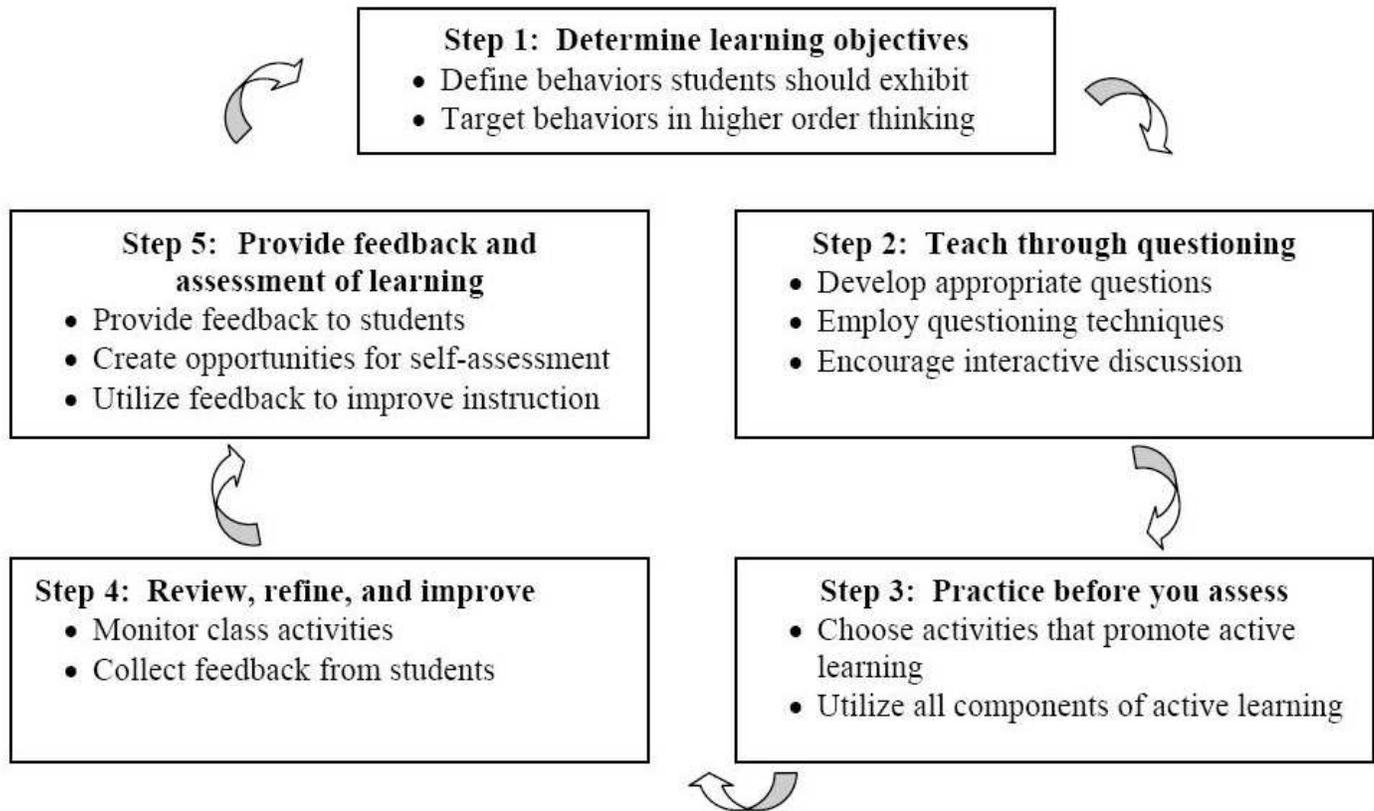
- (published by Synergy Learning), March-April 1995, p. 13.
- <http://www.learnnc.org/lp/pages/780>
 - <http://www.isetl.org/ijtlhe/pdf/IJTLHE55.pdf>
 - <http://www.thinkingeducation.com.au/> (Pohl)
 - http://www.ucalgary.ca/iejll/edmonson_fisher_brown_irby

http://www.nysmsa.org/associations/611/files/ITv25n1_Fall%202007.pdf (Notice, Think, and Wonder Article)

Online Resources:

- <http://delicious.com/mikefisher821/criticalthinking>
- <http://www.criticalthinking.org/>

5-Step Model to Move Students toward Critical Thinking



Examples:

- What makes a good friend?
- What makes a bad storm?
- What kind of TV programs are healthy for us?
- What are the traits of a good leader?
- What makes for a fair punishment?
- What makes one team better than another?
- How is a hero different from celebrity?
- What kinds of harm can be done by fame and fortune?
- What changes need to be made to the Super Fund clean-up program?
- What is creativity and what is its importance for the individual / the culture?
- What is the purpose of: science fiction? satire? historical novels, etc.?
- Why has nature inspired so many artists over time?
- What are the elements that build a strong friendship?
- What impact does family have during different stages of our lives?
- What can we learn from different generations?
- How is conflict an inevitable part of relationships?
- How do we know how to make good decisions?
- How can a person's decisions and actions change his/her life?
- How do the decisions and actions of characters reveal their personalities?

Essential Questions

DBQ Analysis

- Ask a question
- Analyze different aspects or parts
- Collect clues about those aspects
- Look at all of your clues to draw conclusions about what you think (with your clue as evidence for thinking what you think)
- Share your drawn conclusions with others and do comparative analysis.
- Were you able to answer your question?



Question Stems

Questions for Remembering

- What happened after...?
- How many...?
- What is...?
- Who was it that...?
- Can you name...?
- Find the definition of...
- Describe what happened after...
- Who spoke to...?
- Which is true or false...?

Questions for Understanding

- Can you explain why...?
- Can you write in your own words?
- How would you explain...?
- Can you write a brief outline...?
- What do you think could have happened next...?
- Who do you think...?
- What was the main idea...?
- Can you clarify...?
- Can you illustrate...?
- Does everyone act in the way that does?

Questions for Applying

- Do you know of another instance where...?
- Can you group by characteristics such as...?

- Which factors would you change if...?
- What questions would you ask of...?
- From the information given, can you develop a set of instructions about...?

Question for Analyzing

- Which events could not have happened?
- If... happened, what might the ending have been?
- How is... similar to...?
- What do you see as other possible outcomes?
- Why did... changes occur?
- Can you explain what must have happened when...?
- What are some or the problems of...?
- Can you distinguish between...?
- What were some of the motives behind...?
- What was the turning point?
- What was the problem with...?

Questions for Evaluating

- Is there a better solution to...?
- Judge the value of... What do you think about...?
- Can you defend your position about...?

- Do you think...is a good or bad thing?
- How would you have handled...?
- What changes to... would you recommend?
- Do you believe...? How would you feel if...?
- How effective are...?
- What are the consequences...?
- What influence will...have on our lives?
- What are the pros and cons of...?
- Why is...of value?
- What are the alternatives?
- Who will gain & who will lose?

Questions for Creating

- Can you design a...to...?
- Can you see a possible solution to...?
- If you had access to all resources, how would you deal with...?
- Why don't you devise your own way to...?
- What would happen if...?
- How many ways can you...?
- Can you create new and unusual uses for...?
- Can you develop a proposal which would...?

(Pohl, Learning to Think, Thinking to Learn)

Marzano's 9 Instructional Strategies

1. Identifying Similarities and Differences

- Allows understanding of complex problems in a simple way
- Use Venn diagrams/Double bubble map
- Create metaphors, analogies

2. Summarizing and Note Taking

- Must delete, substitute and /or keep information
- Provide set of rules for creating a summary
- Use teacher prepared notes
- Use consistent format for notes (Cornell)

3. Reinforcing Effort and Providing Recognition

- Share success stories
- Keep log of efforts and achievements
- Personalize recognition
- Pause, Prompt, Praise

4. Homework and Practice

- Establish homework policy
- Vary feedback
- Focus practice on difficult concepts

5. Nonlinguistic Representations

- Use Graphic Organizers
- Use Diagrams
- Move for representation

6. Cooperative/Collaborative Learning

- Vary grouping
- Apply consistently and systematically

7. Setting Objectives and Providing Feedback

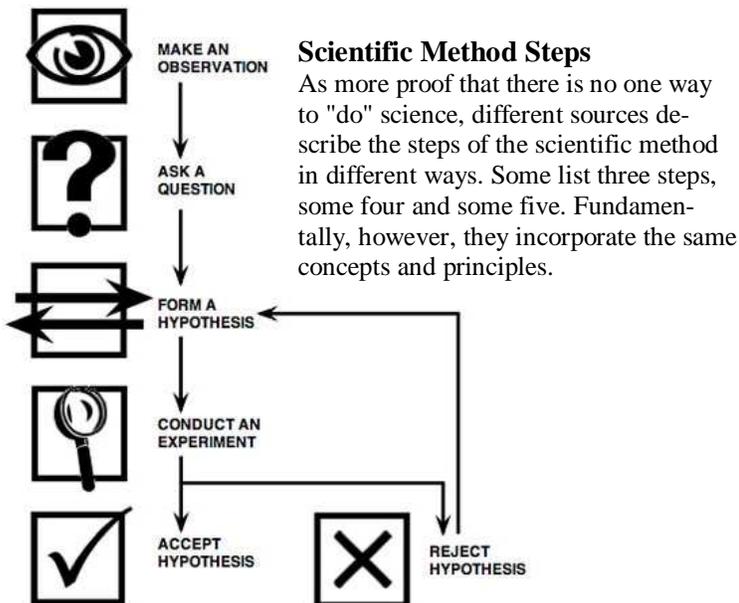
- Encourage students to internalize goals
- Use corrective, timely, specific feedback

8. Generating and Testing Hypotheses

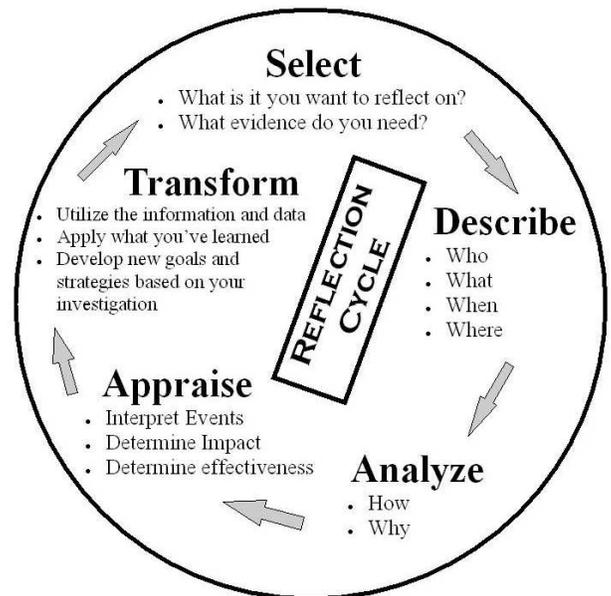
- Predict
- Build something with limited resources

9. Cues, Questions, Advance Organizers

- Wait before answering
- Vary organizers



Problem Solving



Reflection

Excerpt from **“Notice, Think, and Wonder: New Pathways to Engage Critical Thinking.”** (Mike Fisher and Nancy Cook)

We know that learning can't be a rote process; it has to be a right process, with an emphasis on pathways and journeys versus an end product. The journey is where critical thinking occurs and we want to promote the necessity of process over product, of abstract over concrete, of discussion over comprehension questions.

To that end, we wanted to find a way to meet students where they need to be met, involve technology, and increase the level of critical thinking in our classrooms. To achieve that goal, we had to decide what our desired outcome would be and consider the tools that would get us there.

To begin with, we decided that students needed to consider more than just the surface level of the information we were presenting. We knew that the thought-provoking insights and illuminating ideas we would like our students to come up with are dependent on the details with which they can be supported, but we also wanted them to be in a constant state of questioning, critiquing, analyzing, evaluating, and transforming what they are learning. Our goal was to move their existing thinking processes outside of their current zone and help them to recognize that thinking is a skill that must be practiced as diligently as any other skill if you are to be proficient at it.

When facilitating critical and creative thinking, we cannot plan ahead for the “correct” answer. Our aim is for students to combine new information with what they already know to create an idea or product that is useful and unique. We help students make learning

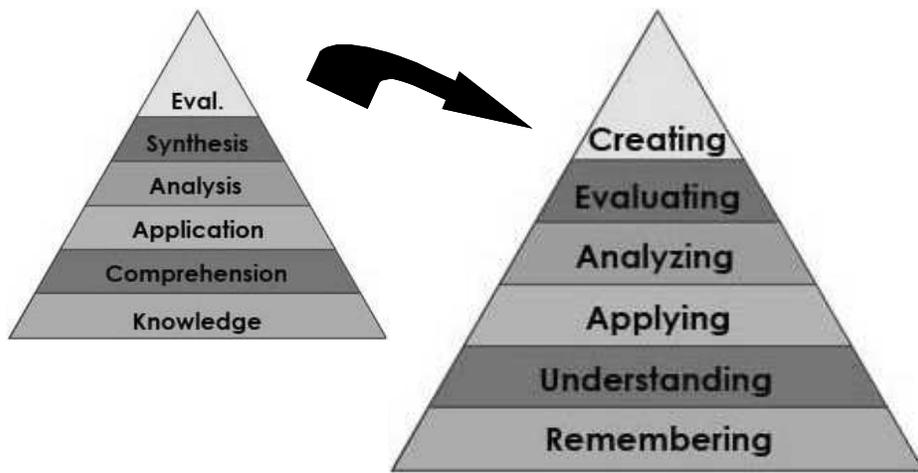
more meaningful and personal by providing them opportunities to gather the content knowledge, make connections to concepts, connect the concepts to their own lives, and create ideas and products that bloom from the seeds of what they already know.

If we want our students to Notice, Think, and Wonder about their learning, then we have to Notice what our needs are, Think of ways to improve them, and then Wonder why we didn't implement these types of strategies before now.

Our efforts proved, once again, that traditional or concrete learning methods are no longer the most appropriate teaching choice. Sometimes the teacher has to move beyond the confines of the conventional (and habitual...) and find ways of engaging and motivating students so that learning is authentic and personally meaningful to each student.

Level	Discussion	I notice...	I think...	I wonder...
4	Speaking and listening are balanced like in a natural conversation. Responses are related directly to the topic being discussed. Appropriate eye contact is used.	Focuses on subtle facts or details which are related to key understandings.	INSIGHTFUL...identifies key understandings and their significance clearly, sees connections between ideas, supports opinions with persuasive, clear evidence, and sees subtleties and ironies in alternate points of view.	Question invites discussion promoting more than one point of view, personal connections, and understanding of the story or topic.
3	Speaking is balanced with listening. Responses usually relate to the topic being discussed. Eye contact may be limited.	Focuses on obvious facts or details which are related to key understandings.	PERCEPTIVE...helpful interpretation of key understandings, sees more than one point of view, supports opinions with clear evidence, and begins to make personal connections to ideas.	Question invites discussion with more than one point of view. Discussion of the question will increase understanding of the story or topic.
2	Speaking and listening are unbalanced. Responses are not always related to the topic being discussed. Eye contact may be limited.	Focuses on subtle facts or details without connecting them to key understandings.	AWARE...a reasonable/sensible response goes beyond facts, starts to look for meaning, and supports opinions with limited evidence.	Question invites discussion and begins to explore key understandings.
1	Unprepared or participates minimally in discussions. Seems distracted, not focused on discussions.	Focuses on obvious facts or details without connecting them to key understandings.	EMERGING...restates what was read or taught, jumps to conclusions without support, simple or superficial understanding of meaning.	Question invites discussion of unimportant facts or details which are not related to key understandings.

Notice, Think, and Wonder



In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. During the 1990's a new group of cognitive psychologist, lead by Lorin Anderson (a former student of Bloom's), updated the taxonomy reflecting relevance to 21st century work. The graphic is a representation of the NEW verbiage associated with the long familiar Bloom's Taxonomy. Note the change from Nouns to Verbs to describe the different levels of the taxonomy.

- **Remembering:** can the student recall or remember the information? define, duplicate, list, memorize, recall, repeat, reproduce state
- **Understanding:** can the student explain ideas or concepts? classify, describe, discuss, explain, identify, locate, recognize, report, select, translate, paraphrase
- **Applying:** can the student use the information in a new way? choose, demonstrate, dramatize, employ, illustrate, interpret, operate, schedule, sketch, solve, use, write.
- **Analyzing:** can the student distinguish between the different parts? appraise, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test.
- **Evaluating:** can the student justify a stand or decision? appraise, argue, defend, judge, select, support, value, evaluate
- **Creating:** can the student create new product or point of view? assemble, construct, create, design, develop, formulate, write.

A DBQ, document based question, is a question that focuses around one or more documents. The documents can be a graph, cartoon, short excerpt, picture, etc, basically anything that a child can glean information from.

In New York State, beginning in fifth grade, the state tests in Social Studies have a DBQ Essay. The children look at 2 to 7 documents (depending on the grade), answer 4 questions, then write an essay using their answers to those questions.

Students have to analyze the documents and write an essay around the designated theme that incorporates information from the documents.

Breaking Down DBQ's

These are some tasks that students could be asked to do in a DBQ:

- Analyze: Break a topic down into separate parts and discuss each one.
- Criticize: Make judgments. Evaluate comparative worth.
- Define: Explain the exact meaning, specific to the course or subject.
- Describe: Give a detailed account, listing characteristics, qualities and parts.
- Discuss: Argue the pros and cons of an issue.

- Evaluate: Give an opinion or cite the opinion of an expert.
- Illustrate: Give concrete examples.
- Summarize: Give a brief, condensed account, including conclusions.

An essential, or driving question is a question that gives a reason for the student to study the subject or unit. To find these questions look for unifying themes in units as well as ways to connect these units to kids' lives. Aim for questions to get at the root of what is being taught: Why is this historical event or time period important? Why do we need to know about it? How does/did it affect our lives today? How much time do I spend on it?

DBQ's and Essential Questions make the learning have purpose. The students are trying to reach the goal of answering the essential question. They connect the huge amount of factual information kids need to learn. The essential questions also help students learn to connect and interpret facts in order to answer questions and define themes and eras. History, for example, becomes for them not a memorizing of facts but rather a quest for meaning. By posting the essential questions teachers and students stay on 'track.' They can be used as guides to keep classroom discussion on topic, as writing assignments following a unit of study, as a way to integrate between disciplines and also as a way to communicate with parents.

DBQ Analysis