



# Tools for Reading and Writing in Inquiry Science: Get Connected

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“Every classroom teacher has the direct responsibility for developing those reading skills and abilities essential for adequate comprehension with his particular area of instruction, as well as for applying to his content field and making functional those skills and abilities being developed by teachers in other areas of instruction.”

(Artley, 1944, p. 464)



“Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers; explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking and consideration of alternative explanations.”

(Miller, 2006)





# Features of Inquiry Science

Students at every grade level will:

- Ask and be engaged by scientific questions
- Give priority to evidence as they make predictions, plan and conduct investigations using appropriate tools and techniques
- Think critically and logically about the relationships between evidence and explanations
- Construct and analyze alternative explanations
- Communicate scientific arguments

**Emphasis is placed on:**

**Observation**

**Questioning**

**Data Collection and Analysis**

**Critical Thinking**





## Reading is Critical for Success in Science

- Literacy skills are required to access the body of knowledge and data of science
- Students are unable to gain depth and breadth of scientific knowledge if they can't learn from texts
- In the current age of information the ability to read informational text critically and analytically is crucial
- Scientific knowledge is accumulated and published as expository text
- Expository text is typically
  - Technical
  - Dense
  - Abstract





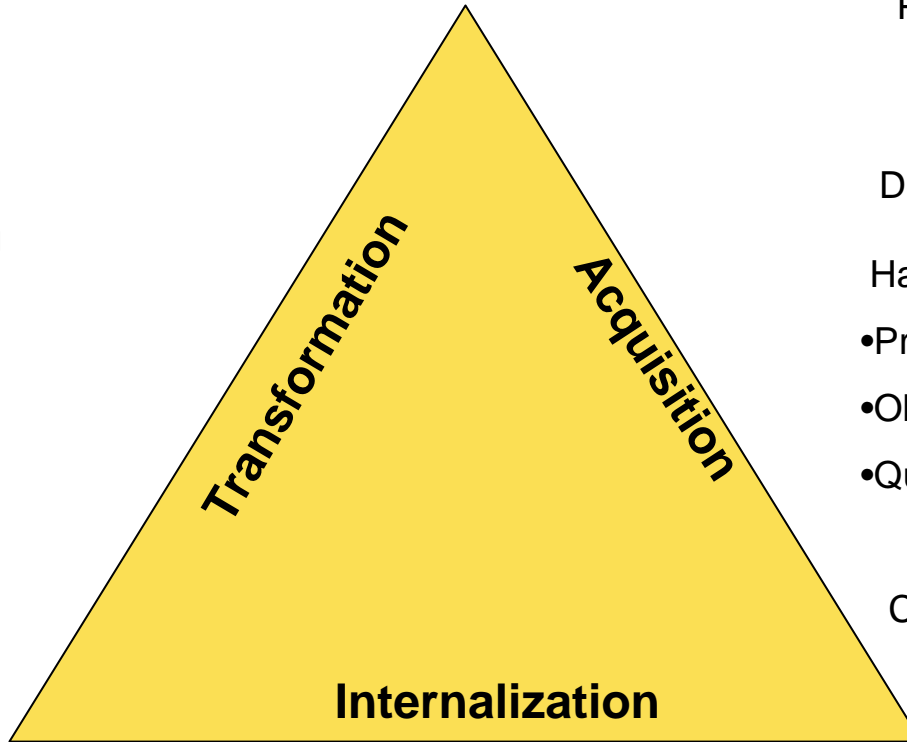
# Miller's Science-Cognition-Literacy Framework



Communicating Knowledge to Others

Process Writing  
Develop-Draft  
Review-Revise  
Polish-Publish

Application to new situations and concepts



Prior Knowledge Activation

Developing Inquiry Skills Through Hands-On Activities

- Prediction
- Observation
- Questioning

Content Reading

Practice and transfer of cognitive skills from inquiry to reading and writing

Interpretation of scientific evidence

Assessment of understanding by self and peers

(Miller, 2006, p. 31)



## Key science inquiry Skills and Reading Applications

Science inquiry skill	SCL phase	Reading application to be taught to students
Prediction	Acquisition	Before reading, students should preview the text and predict what the reading sample is about from the title, illustrations, and other key text components. As students read, students should constantly predict and anticipate what the next points to be discussed in text will be.
Observation	Acquisition and Internalization	Students use their observation skills to take note of key points in text—headings, boldface terms, illustrations, special use of language. Students should use contextual clues from the reading to decode new vocabulary, observing where and how the new terms are used and what supporting vocabulary and ideas are used to extend their meaning.
Questioning	Acquisition and Internalization	The K-W-L technique can be used before, during, and after reading to generate questions related to student knowledge. As they read, students should make margin notes and use the think-aloud strategy to sketch questions on the reading sample (or extra paper) to provide a concrete reminder of points that were not understood and need to be discussed in small groups or with the teacher. During the reflection activities, students must constantly self-assess their understanding of the reading, questioning themselves and posing questions to others as appropriate.
Planning	Acquisition	When students preview the reading sample, they should examine the structure of the text (sequential, descriptive, compare/contrast, etc.) and select an appropriate graphic organizer or other organizing tool (such as a T-chart) to use while reading to organize the points of information in the text.
Reviewing, analyzing, and interpreting data	Internalization	After reading, students should review what they have read and revisit and revise their graphic organizers if necessary, reconstructing their ideas and incorporating their knowledge from the hands-on activities with what they have read.
Explaining and communicating	Transformation	Students should be required to explain, both orally and in writing, what they have read. Doing so strengthens reading comprehension and science content knowledge.





# Making Sense of Expository Text Structures

## Six Expository Text Structures

- Generalization/Description
- Sequence/Chronological Order
- Cause and Effect
- Problem and Solution
- Compare and Contrast
- Question and Answer





## Generalization/ Description

The author states a generalized main idea statement and proceeds to defend the argument with supporting details such as facts, reasons or examples.

### Key Words That Signal Generalization/Description

For example

Look at

Such as

Like, as

Some characteristics are

By observing





## Sequence/Chronological Order

- Putting facts, events or concepts into a sequence.
- Time reference may be implicit or explicit.
- A sequence is evident in the pattern.

### Key Words That Signal Sequence/Chronological Order

Until

After

Finally

Now

First/Last

On (date)

At (time)

Then

Before

Next

First, second, third





## Cause/Effect

Showing how effects such as facts, events or concepts happen or come into being because of other facts, events or concepts.

### Key Words That Signal Cause/Effect

Since                      So that                      Nevertheless                      Because

Then                      This led to                      As a result                      So

Due to                      Thus                      Accordingly                      Therefore

For this reason                      If...then                      Consequently





# Problem and Solution

Describes a problem and its cause and offers one or more solutions

## Key Words That Signal Problem and Solution

One reason is

Outcome is

A solution

Issues are

A problem

Solved by





# Compare and Contrast

Pointing out likenesses (comparison) and/or differences (contrast) among facts, people, events, concepts and so on.

## Key Words that Signal Compare and Contrast

Less than	However	Other	Difference
Differently	And yet	Similar to	Like
Same as	Different from	Similarly	But
Nevertheless	As opposed to	Likewise	While
Either...or	Neither...nor	Least	Most
On the other hand	More than	Unlike	Not only...but also





# Question and Answer

A question is posed about a topic, event, concept or an idea, causes of the problem are presented and one or more solutions is offered.

## Key Words that Signal Question and Answer

How

Why

When

Who

Where

It could be that

What

How many

It's possible to  
conclude





# Reading Skills Necessary for Learning Science as Inquiry

- **Activation of Prior Content Knowledge**
  - Prepares students to make logical connections, draw conclusions and assimilate new ideas
  - Teachers can determine students' existing perceptions and misconceptions
- **Mastery of Vocabulary**
  - Terminology is often unfamiliar and abstract
  - Each scientific discipline has language of its own
- **Comprehension**
  - Construction of meaning as a result of Intentional thinking and interactions between text and reader
- **Making Sense of Text Style**
  - Necessary for comprehension and recall of information
  - Enables student to form mental representation of information
  - Helps students to see logical relationships
  - Improves students' writing abilities

(Miller, 2006, p. 30)





## Reading Strategies: Why Teach Them?

- Students who struggle with text should become aware of, use and develop control over learning strategies.
- Students should not only learn WHAT to do, but why, how and when.

### Steps for Strategy Instruction

1. Assessment
2. Explanation and awareness
3. Modeling and demonstration
4. Guided Practice
5. Application





# Teaching Reading Strategies

- Review steps students should follow.
- Demonstrate by walking students through the steps. Provide explanations!
- Model use by initiating a think-aloud procedure.
- Guided practice- Allow students to have a trial run with short selections of text.
- Application- Require students to apply strategies in class assignments.





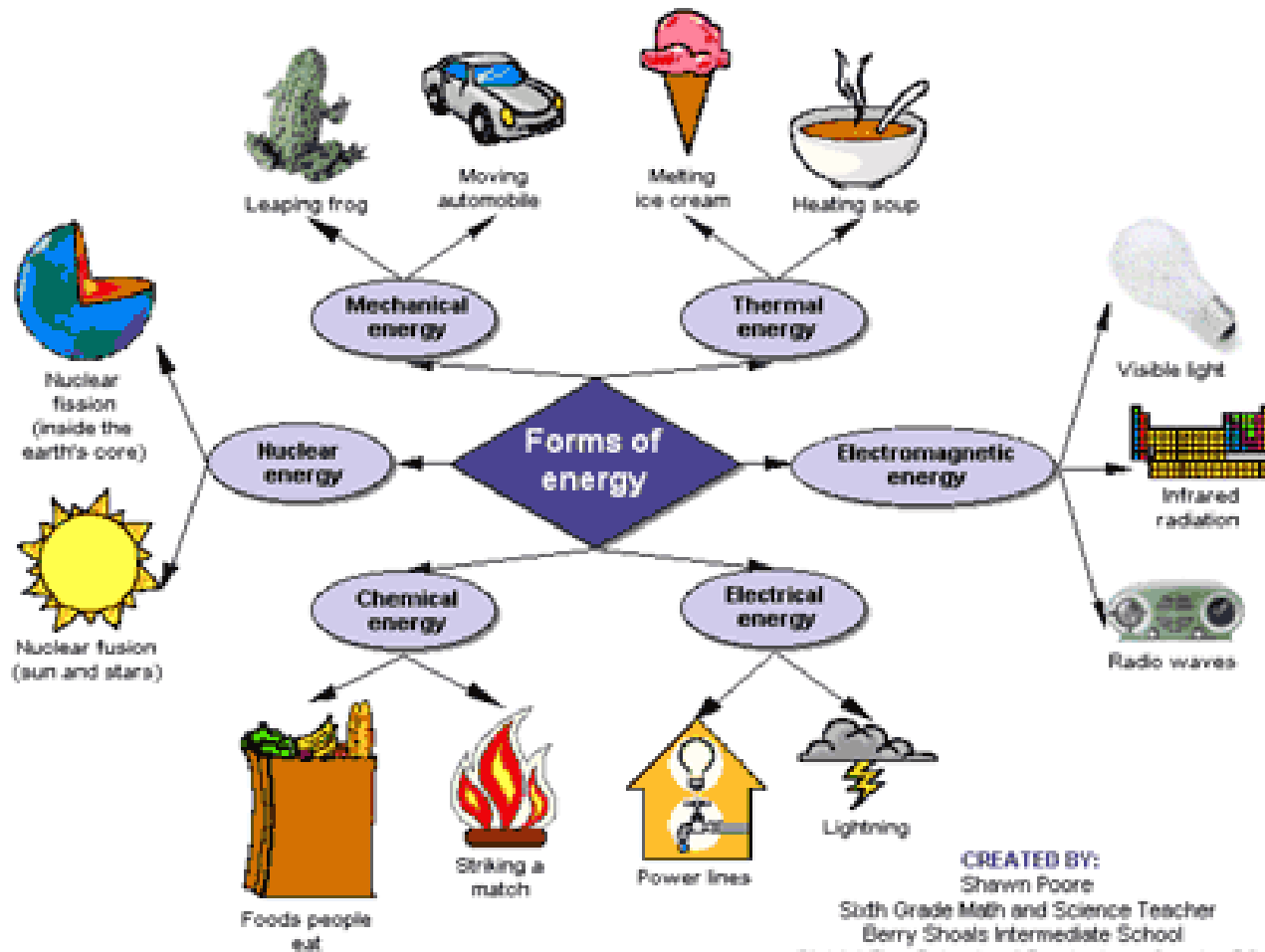
# Strategies for Activating Prior Knowledge

- Webbing
- KWL, KWLH, KLEW
- Anticipation Guide
- A Brief Look
- Semantic Mapping





# Webbing



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# KLEW



<b>K</b> What do we Know?	<b>L</b> What are we Learning	<b>E</b> What is our Evidence	<b>W</b> What are we Wondering?



# Anticipation Guide

**Instruction:** Respond to each statement twice: once before the lesson and again after reading it.

Write **A** if you agree with the statement

Write **B** if you disagree with the statement

Response Before Lesson	Topic	Response After Lesson
	The plasma membrane is a double layer of protein.	
	The mosaic model describes the current understanding of cell membrane structure.	
	The plasma membrane is partially impermeable.	
	The term hypertonic is a relative term and indicates that a solution is more concentrated than the one it is being compared to.	





# Strategies for Mastering Vocabulary

- Concept Definition Mapping
- Frayer Model
- Semantic Feature Analysis
- Word Sorts
- Prefixes/Suffixes





# Pre-Reading Strategies

- Activation of Prior Content Knowledge
- Thinking About My Text
- Reading Detective
- Categories, Categories, Categories,
- From Another Perspective
- Paired Reading
- How to Get to the Root/Prefix/Suffix of IT
- Toss 'Em in the Sack





## During Reading Strategies

- Information Goes Round and Round
- Charting What I Think
- Write-Pair Share
- Analogies
- Digging for Meaning: Above Ground Notes
- Discussion Seed
- Another Kind of Outline
- Bow Tie
- It all Comes Together



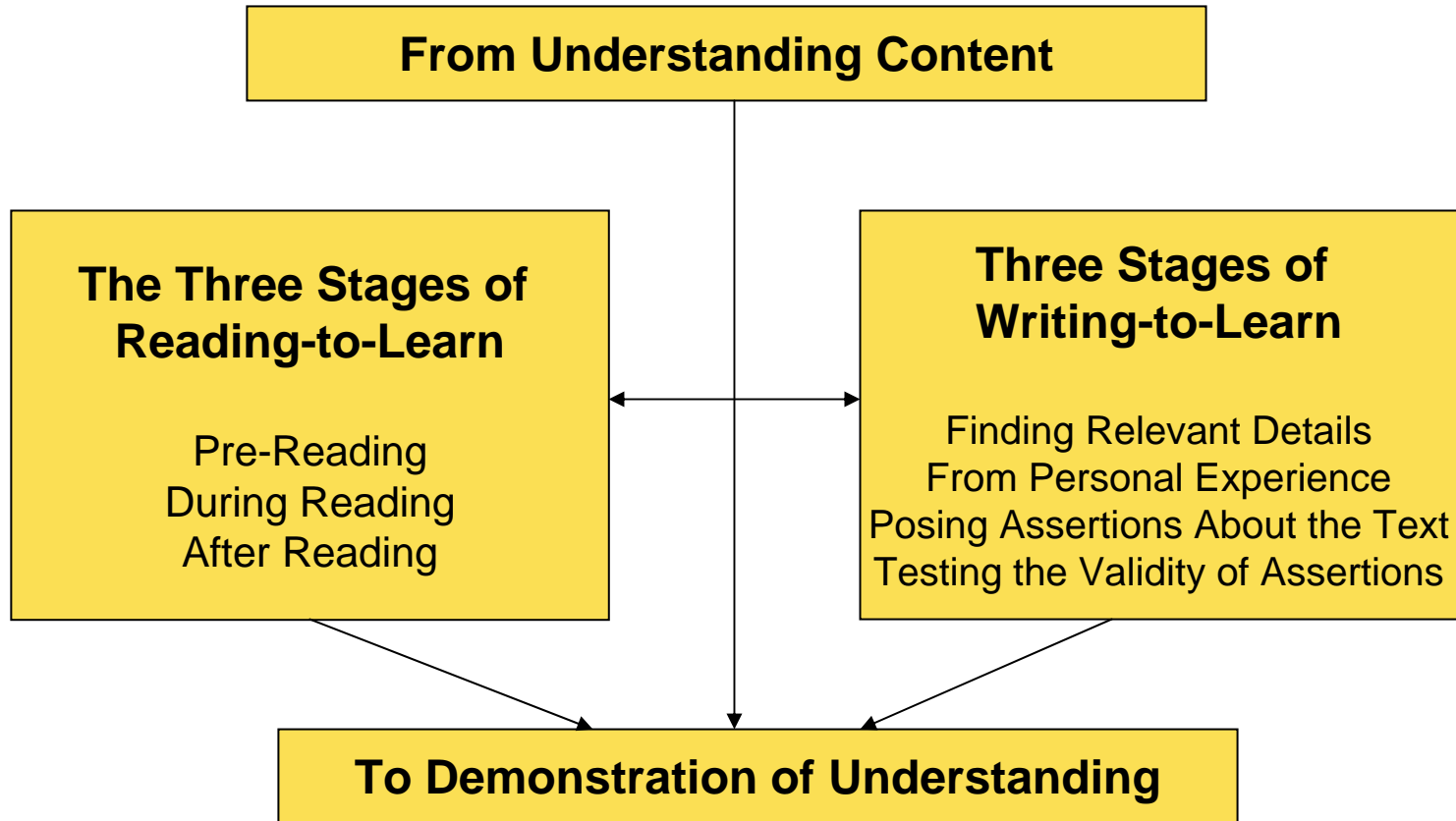


# After Reading Strategies

- Just for Chem Lab
- My Own Think Aloud
- Ticket Out of Here
- Sum it Up!
- Line Graph
- Summarizing Expository Reading
- 2 X 2 Thinking
- Summarize! Together We Say It Better
- Summary Frame (good for news article)



# Interrelation Among Reading, Writing and Understanding



(Jacobs, 2002, p. 60)



# Explaining and Communicating in Science Through Writing

## The Rationale

- Develops skills in critical thinking and synthesis of information
- Concepts are refined and extended by students
- Requires clarification of ideas by students
- Motivates students to ask questions, do research and think creatively
- Helps students select appropriate data from which to draw a conclusion
- Provides a means for analysis and evaluation
- Students think and organize thoughts before writing, thus allowing for internalization
- Helps students connect experiences with subjects
- Reading comprehension is fostered and content knowledge deepened.





# Writing Activities

- Poems
  - Bio Poem
  - Cinquain
  - Now and Then
- RAFT
- Science Journal
- Expository Writing Organizer
- Writing a Scientific Paper
- Writing a Lab Report





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