




Independent Reading Practices for Mathematics and Science Students

A Texas Higher Education Coordinating Board Project in Conjunction with:

Stephen F. Austin State University
Department of Secondary Education
and Educational Leadership
College of Sciences and Mathematics

Rural High Schools
Hudson High School
Lufkin High School
Nacogdoches High School
Woden High School

Angelina College
Mathematics and
Science Division

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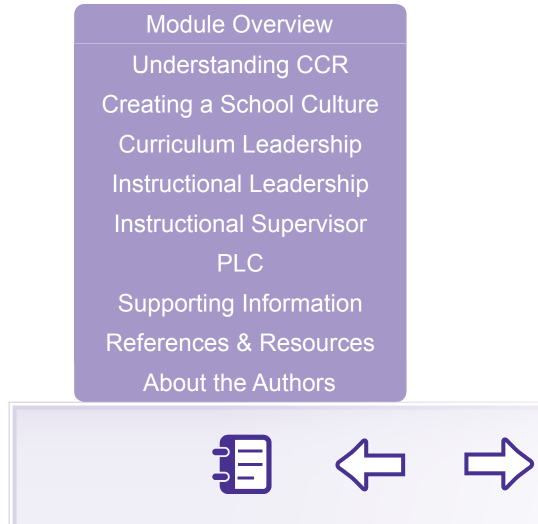

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Watch the video Independent Reading Practices for Mathematics and Science Students.

Module Overview

Students currently attending Texas public schools are destined to enter a globally competitive, highly interactive job market upon graduation, an environment which has no historical precedent. In an effort to meet the challenges imposed by this new economic/ employment landscape, the state has developed and integrated the Texas College and Career Readiness Standards (CCRS) into the Texas Essential Knowledge and Skills. These new standards define what students should know and be able to do at entry-level, postsecondary environments, be they university, college, or career settings. The CCRS focuses upon four content areas: English, mathematics, social studies, and science. Additionally, the CCRS addresses the Cross-Disciplinary Standards, those skills that should permeate all content areas. As organized, the CCRS define what secondary curricula must accomplish in order to prepare students for post-high school realities.

With the alignment of the state's secondary curricula to the College and Career Readiness Standards, Texas high school students should attain a higher level of preparation for life after graduation, a future expected to offer an increasingly complex employment landscape. However, certain traditions continue to threaten the curricular innovations of the CCRS, specifically a myopic perspective that envisions only select students as college or career capable while others are destined for vague, less secure work futures. The reality, as envisioned by the articulation of the CCRS, dictates that today all students must be highly prepared for the dynamic 21st century workplace. Inherent in this vision is the recognition that all students must be ready for postsecondary education or career training that demands the same knowledge, skills, and dispositions as entry-level college or university course work. In short, today every student matters and every student must be prepared to be successful in the 21st century employment milieu.

Module Overview

The Systemic Teacher Preparation Sites (STEPS) grant is a collaborative between Stephen F. Austin State University, Angelina College, and four rural high schools located within Hudson ISD, Lufkin ISD, Nacogdoches ISD, and Woden ISD. The partnership of these entities, along with three others, collaborated to design this module for the benefit of pre-service and in-service math and science teachers.

Over the course of the grant's initial year of work, participants discovered a sound alignment between high school content and the College and Career Readiness Standards. Yet, challenges remained for those participating in-service and pre-service teachers in their efforts to resolve the following:

- how to integrate 21st century skills into teacher repertoires,
- how to embed the cross-disciplinary skills in demonstration lessons,
- how to teach reading comprehension skills in mathematics and science, and
- how to generate meaningful assessment examples that mirrored the rigor of classroom content and instruction.

Module Overview

As a result of these challenges, STEPS participants developed learning modules around the four galvanizing areas. These modules are: 21st Century Learning Skills and the College and Career Readiness Standards, The Importance of Using the Cross-Disciplinary Standards in Mathematics and Science, Independent Reading Practices for Mathematics and Science Students, and The Importance of Meaningful Classroom Assessment in Promoting College and Career Readiness.

Each module provides available research and resources regarding the respective topic, briefly defines key components of the topic, and provides content area examples.

The STEPS team has prepared the instructional module for approximately one to one and one half hours of professional development. The modules are designed as a resource, not an exhaustive compilation of the subject. We recommend that the in-service and pre-service teachers review all four modules.

While the module may appear content-dense at first glance, it is designed to be flexible and self-paced, providing an opportunity for the reader to review and reflect upon all sections or choose only areas in which they are not familiar or have concerns.

> *"We encourage you, as teachers of Texas students, to incorporate the instructional expectation of the College and Career Readiness Standards into your daily practice; our students are worth it."*
> *(STEPS team)*

Components of the Module

With reading comprehension as an essential aspect of successful study in science and mathematics, this module explores reading strategies that students can employ to enhance their comprehension of mathematics and science texts.

The STEPS team adheres that as teachers model these strategies, students will learn to independently utilize them as they ascertain their own metacognition, how they learn, which enables them to be more successful learners.

The module provides concrete examples of how the College and Career Readiness Standards pertaining to reading are connected to mathematics and science problems.

Figure 1 defines the module design with its discussion of pre-reading, during reading, and post–reading strategies and their importance, as well as implementation by students as they strive to become independent readers in mathematics and science content.

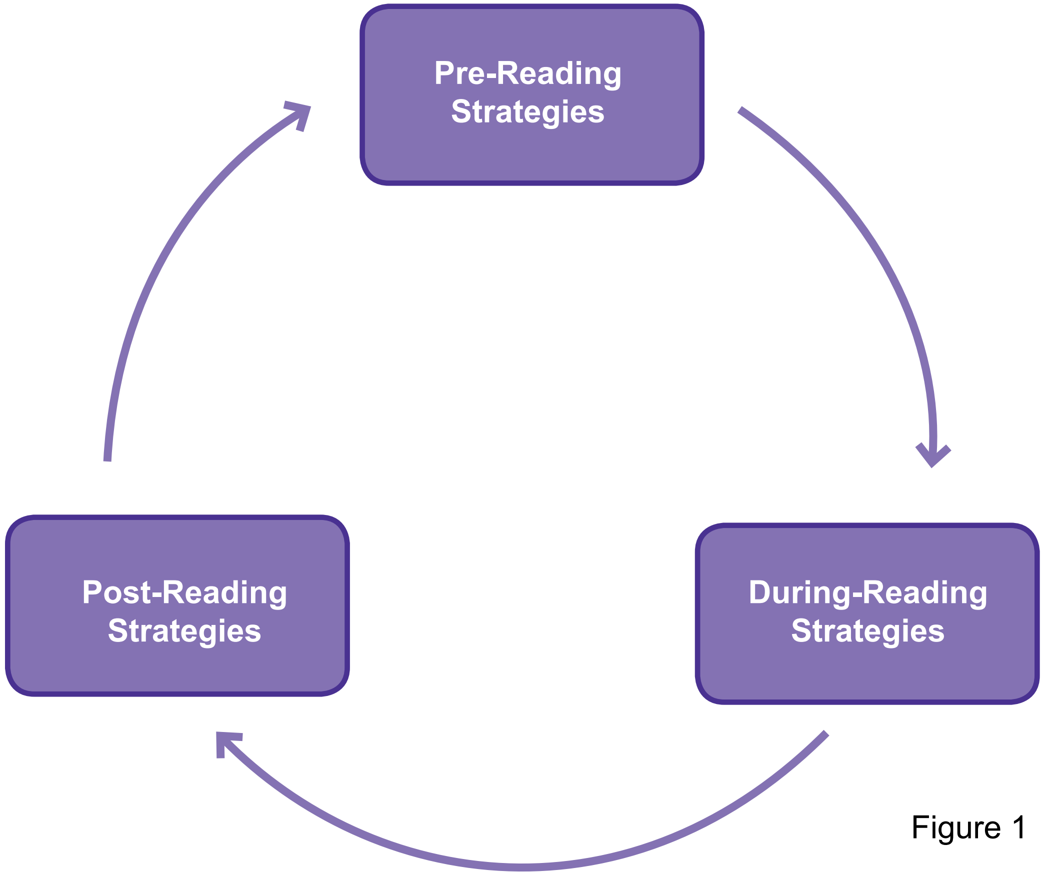


Figure 1

Introduction to an Independent Reader

Exploring an Independent Reader for Mathematics and Science

An independent reader in mathematics and science is a reader who continuously monitors his/her understanding of the text while they are reading. For mathematics and science texts, this requires them to predict, question, connect, and summarize. Modeling to mathematics and science students strategies that demonstrate how a good reader thinks can build the capacity for independent readers. Concrete strategies presented in this module will provide numerous example of techniques mathematics and science teachers can model for their students to gain such skills.

Independent readers understand that reading is a process, not an activity of merely calling words. As noted in Table 1, this module will focus on the process with the goals of readiness, understanding, and retention throughout three stages: pre-reading, during-reading, and post-reading.

	Purpose	Comprehension Process
Pre-Reading	Readiness	• Activating Prior Knowledge • Predicting
During-Reading	Understanding	• Constructing Meaning • Monitoring Understanding
Post-Reading	Retention	• Processing Ideas • Applying Knowledge

Table 1

The Importance of Modeling Independent Reading Strategies in Mathematics and Science

Many students inherently develop their own reading comprehension schema; however, some do not unless directly taught. The teacher can enhance students' success by teaching them strategic reading skills that students can then apply independently at the postsecondary level or in a career setting.

Reading Comprehension Challenges

Mathematics and science present reading comprehension challenges not noted in most narrative texts. Barton (2002) stresses, "Mathematics requires students to not only read from left to right, but also right to left, top to bottom, and often diagonally. It too contains more concepts per word, per sentence, and per paragraph than any other kind of text" (2002, p. iv). Mathematical and science texts are typically written to condense large amounts of information with minimal redundancy. Students must not only decode words but also diagrams, tables, graphs, symbols, and pictures and structures. This makes teaching strategic reading strategies critical to enhance student success.

Reading a science textbook also presents unique challenges to students. Barton (2002) points out the importance of vocabulary to comprehension: "A high school chemistry book can contain some 3000 new vocabulary terms. When students do not recognize words, they use too much of their processing capacity to read individual words which ultimately interferes with their ability to comprehend what is read" (2002, p. iii). To understand science content, the student must be able to follow scientific writing that contains significant factual content.

The Pre-Reading Stage: Its Connection to CCR

Exploring Pre-Reading for Mathematics and Science

During the pre-reading stage, the reader establishes a clear understanding of the purpose for the reading. The reader should actively ask questions, make predictions, and activate prior knowledge.

By walking through the process, teachers are modeling what good readers do before attempting an unfamiliar piece.

Importance of Pre-Reading Strategies

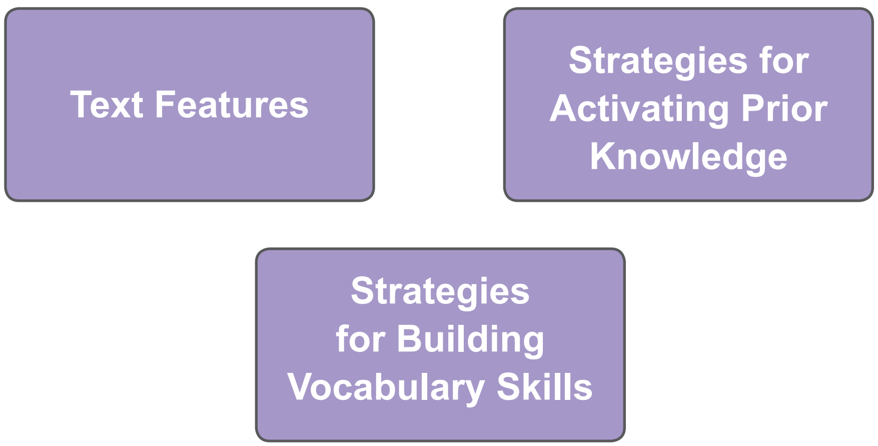


Figure 2

This stage:

- reduces uncertainty that students bring to an assignment,
- links students' experience to the text,
- motivates students to read,
- develops metacognitive awareness of the demands of the assignment, and
- creates a framework for reading.

When students have a purpose for reading, that purpose directs their reading towards a goal, as well as assists them in attending to the demands of the reading.

As noted in Figure 2, this section will review three pre-reading strategies including text features, strategies for activating prior knowledge, and strategies for building vocabulary skills.

Connecting Pre-Reading Stage to the College and Career Readiness Standards

Pre-reading strategies are addressed directly in the Cross-Disciplinary Standards, Foundational Skills (in the below link), where use of effective pre-reading strategies is required.

Pre-reading is also acknowledged in the science standards. In scientific reading, students are to list, use, and give examples of specific strategies before reading to improve comprehension.

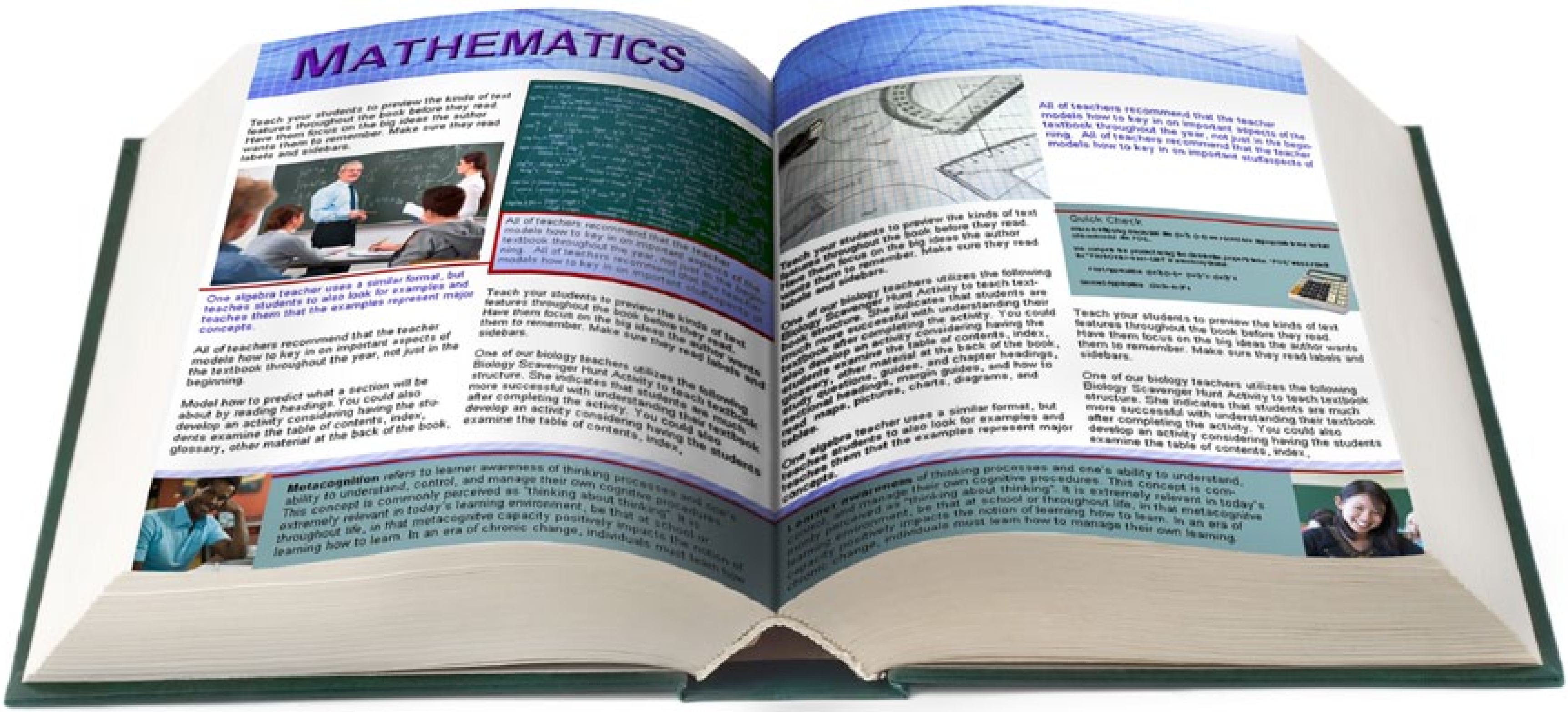
Learn more about Cross-Disciplinary Standards and Science Standards.

Metacognition refers to learner awareness of thinking processes and one's ability to understand, control, and manage their own cognitive procedures. This concept is commonly perceived as "thinking about thinking." It is extremely relevant in today's learning environment, be that at school or throughout life, in that metacognitve capacity positively impacts the notion of learning how to learn. In an era of chronic change, individuals must learn how to manage their own learning. This includes understanding one's preferred approaches to learning, one's control over the learning process, and awareness of one's self as a learner.

(SFA Secondary Education faculty)

Pre-Reading Stage: Text Features

Text presentation defines the way in which the textbook physically lays out the text, including Table of Contents, Glossary, Index, Bold Words, Headings and Titles, Maps, Diagrams, Illustrations, and Charts.



Importance of Text Features

Text Features help the student to identify the big ideas and topics on which the author is focusing. Visual text features, such as maps and charts, help to support the information the author presents in the text. The flow in math textbooks is somewhat different than other textbooks with a more columnar approach rather than a left to right sequence and frequent reference to visuals, charts, graphs, and data.

Strategy: Pre-Reading Stage

Text Features

- Teach your students to preview the kinds of text features throughout the book before they read. Have them focus on the big ideas the author wants them to remember. Make sure they read labels and sidebars.

- One of our STEPS biology teachers utilizes the following Biology Scavenger Hunt Activity to teach textbook structure. She indicates that students are much more successful with understanding their textbook after completing the activity. You could also develop an activity that has students examine the table of contents, index, glossary, other material at the back of the book, study questions, guides, and chapter headings, sectional headings, margin guides, and how to read maps, pictures, charts, diagrams, and tables.

- One STEPS algebra teacher uses a similar format, but teaches students to also look for examples and teaches them that the examples represent major concepts.

- All STEPS teachers recommend that the teacher models how to key in on important aspects of the textbook throughout the year, not just in the beginning.
- Model how to predict what a section will be about by reading headings.

Pre-Reading Stage: Activating Prior Knowledge

Many students do not activate their prior knowledge without being taught this strategy. Activating prior knowledge involves recalling existing knowledge related to the problem or text and connecting it to the content being read. When students learn to employ this strategy, they can anticipate information and make inferences about content.

Because mathematics is sequential, this strategy is crucial; typically the student is connecting current knowledge to what has just been taught. For chemistry this may include connecting the concept to a mathematic skill, prior lab skill, or another chemistry skill.

Connecting Activating Prior Knowledge to the College and Career Readiness Standards

We see this skill addressed in the College and Career Readiness Mathematics Standard III. C where students should be able to connect geometry and other mathematical content strands, make connections between geometry, statistics, and probability, and make connections between geometry and measurement. It is certainly seen in Mathematics Standard X. Connections, where students must be able to make connections among the strands of mathematics and make connections of mathematics to nature, real-world situations, and everyday life.

In science, students must be able connect geometry, algebra, and trigonometry to science, as well as make connections between the Mathematics, Science, and the Cross-Disciplinary Themes of matter, energy, change over time, classification, measurement, and models.

Activating Prior Knowledge

What I Know; Want to Learn, What I Learned - KWL

KWL is a strategy that assists students with predicting and connecting new information to prior learned information. Our STEPS science teachers utilize this strategy to engage students, preview a lab, etc. during the What do I know and Want to Learn stages. During the Learned stage, they quickly determine what students understand and check for their misconceptions. Our STEPS mathematics teachers readily use this strategy as they begin a new concept to enhance the students abilities to connect to prior learning.

The teacher provides the students with a KWL chart when introducing a new topic. The teacher can simultaneously post student responses on the board in the same chart format. As students are responding to what they know and are completing their chart, the teacher adds responses to the board chart. Misconceptions are easily noted during this phase of the activity. The teacher leads responses to the second section, 'what do you want to know' while students simultaneously complete and record their answers. The students then read the selection. The teacher asks the students to record what they have learned through the reading or class discussion in the third column. Students then reflect on the differences between what they knew and learned. Any misconceptions are to be corrected.

K What I Know	W What I Want to Know	L What I Learned

Mathematics Example: KWL

Content Objective: Dimensional Analysis

Dimensional analysis involves changing from one unit of measure to another, often using what are known as unit multipliers. For example, to convert from 10 square inches to square yards:

10 square inches x $\frac{1ft}{12in.} x \frac{1ft}{12in.} = \frac{10}{144}$ square feet or ≈.694 square feet

Ben and Ethan were told to fill a grain silo on their grandfather's farm. In order to determine how much grain was needed, they needed to know the volume of the silo. Using an exact model of the silo, they measured its dimensions. They found that the model had a diameter of 4 inches and was 8 inches tall. If 1 inch on the model represents 6 feet on the actual silo, what is the volume of the silo?

Problem defined:

Volume of model = πr^2 x height of the cylinder

Volume of the model = $\pi (2)^2(8)$

Volume of the model = $32\pi \approx 100.53$ cubic inches

To find the volume of the actual silo:

$$\frac{6ft}{1in} x \frac{6ft}{1in} x \frac{6ft}{1in} x\ 32\pi \text{ inches}^3 = 6192\pi\ ft^3 = 21{,}714.7ft^3$$

A possible KWL chart on a dimensional analysis

K What I Know	W What I Want to Know	L What I Learned
• 3 dimensions length width height • It's 3D	If I change a dimension in a 3D figure, how does that affect surface area or volume?	• Changing 1 or 2 dimensions does not create a similar figure. • Volume = original (scale factor)^3

Science Example: KWL

Content Objective: Polar Covalent Bonding

Sometimes electrons tend to spend more time with one atom in the bond than with the other. In such cases, a polar covalent bond develops. Water (H_20) is an example. Since the electrons spend so much time with the oxygen, that end of the molecule acquires a slightly negative charge. Conversely, the loss of the electrons from the hydrogen end leaves a slightly positive charge. Hydrogen bonds result from the weak electrical attraction between the positive end of one molecule and the negative end of another. Hydrogen bonds can form between the positive side of the water molecule and the negative side of another molecule. Likewise, the negative side of the water molecule attracts positive sides of molecules.

K What I Know	W What I Want to Know	L What I Learned
• Water is necessary for life • Water is a molecule made up of 2 H atoms and 1 O atom	• Why do so many substances dissolve in water? • How many water molecules are in a drop of water?	• Polar Molecule • One end positive, one end negative • Each end can attract molecules of the opposite charge • Water and other polar molecules are attracted to the charged ends of the water molecules.

"Keep the KWL chart interactive throughout the lesson."
(STEPS team)

Polya's Problem-Solving Process (PPSP)

Another strategy that activates the student's prior knowledge that can be applied to the reading process for math and science is Polya's Problem-Solving Process (PPSP) . It consists of four basic steps and is most applicable to mathematics and science:

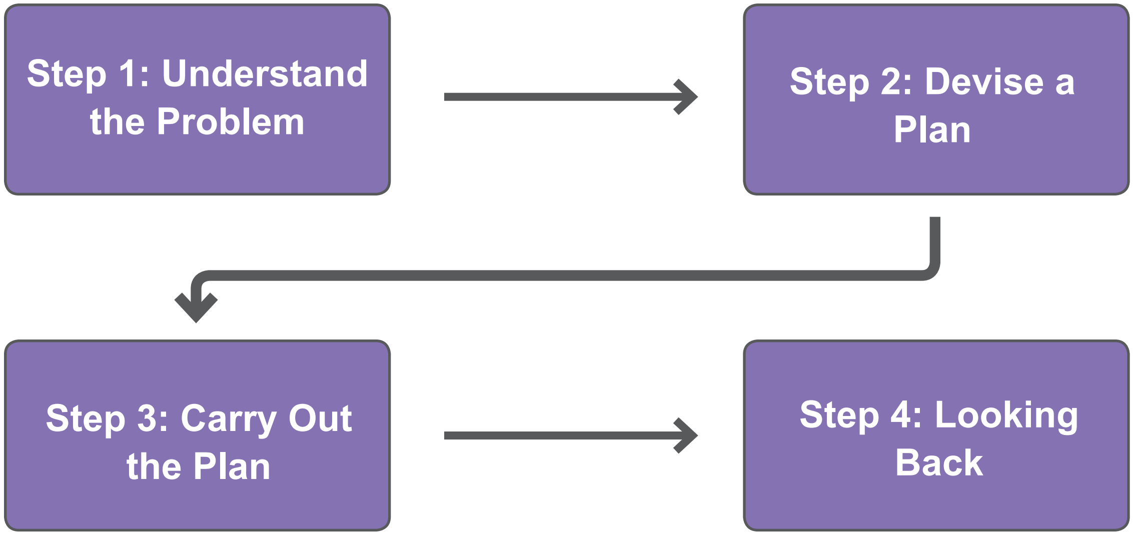


Figure 4

In mathematics and the sciences, attempting to solve a problem (lab assignment, homework exercise, practice problems) highlights reading comprehension deficiencies. Think about how often we hear "I don't get it!" or "I don't know how to start!" Students with these complaints are often stuck on the first two steps of PPSP, understanding the problem and devising a plan. Getting students to recognize that they don't understand the problem is one major hurdle. Teaching them to devise a plan to solve the problem is another.

In thinking about activating prior knowledge, Step 1 and Step 2 are pertinent.

Strategy: Polya's Problem-Solving Process (PPSP)

Activating Prior Knowledge - Polya's Model

Step 1: Understanding the Problem

What do you have to show? One of the most important parts of understanding the problem is making sure that we know the definition of each word in the problem. If a student has to find the vertex of a parabola and he doesn't know what a parabola or a vertex is, it is quite natural to claim "I don't know how to start!" There are many avenues (internet, games, social media, consulting a text) to reinforce vocabulary, but first students need to recognize that their vocabulary knowledge is deficient.

Before pointing to notes, internet or text, we should ask students to restate what they are being asked to do or show to be sure they understand. They can use graphic organizers like Venn diagrams, KWL charts, and others to draw a picture of what they have to show.

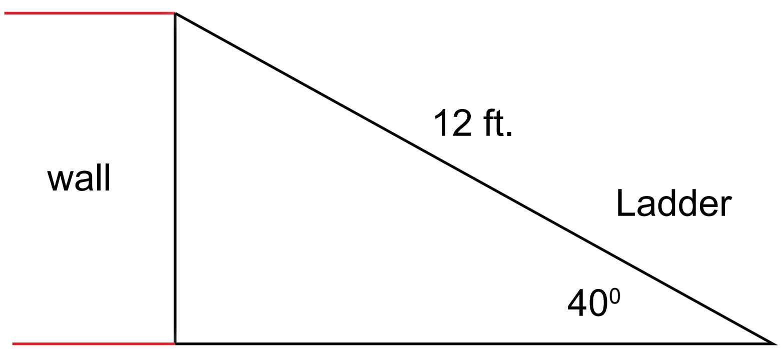
Step 2: What do you know

In devising a plan to solve the problem, students can again use graphic organizers to summarize what they know about a problem. This includes not only definitions, but also previously solved problems, partial solutions, or related concepts not directly referred to but perhaps useful for solving a piece of the problem.

Mathematics Example: Activating Prior Knowledge

Content Objective: Measurement

How far from the wall is the bottom of the ladder?



To solve the problem:

- The student needs to think about what the problem is asking.
- The student needs to get information from the problem.
- 12 ft ladder
- 40^0 angle
- The student needs to ask themselves, "What is missing? What do I need to know?"
- The students must activate prior knowledge before establishing a plan to solve the problem.

Activating Prior Knowledge

Teach the students to brainstorm what they already know how to solve that the problem is requiring.

Probe: What do I know?

- There are 3 angles to a triangle that equals 180^0
- Trig ratios
- $\sin 50^0 = \frac{x}{12}$

Science Example: Activating Prior Knowledge

Content Objective: Significant Figures

Measurement with Precision

While using a 50ml graduated cylinder, you find the volume of a pipe to be 10.45 ml and a pen cap 9.6 ml. Find the average volume of the two objects. If there is any error in the measurement, please explain.

Activating Prior Knowledge

Teach the student to brainstorm what they know about this problem:

- The student knows that the number of digits the number has and reflects the precision of the instrument used to measure it.
- The student knows when taking measurements, always write all values so they show the smallest marking on the instrument, plus an extra digit that you estimate.
- The student knows when multiplying or dividing, the answer should always have the same number of significant figures as the value with the fewest significant figures.

To solve the problem

9.6 ml should be estimated to one more digit than the instrument measured. The reading should be recorded as 9.60 ml. You do not round to the nearest tenth of a ml (10.45 is not 10.5).

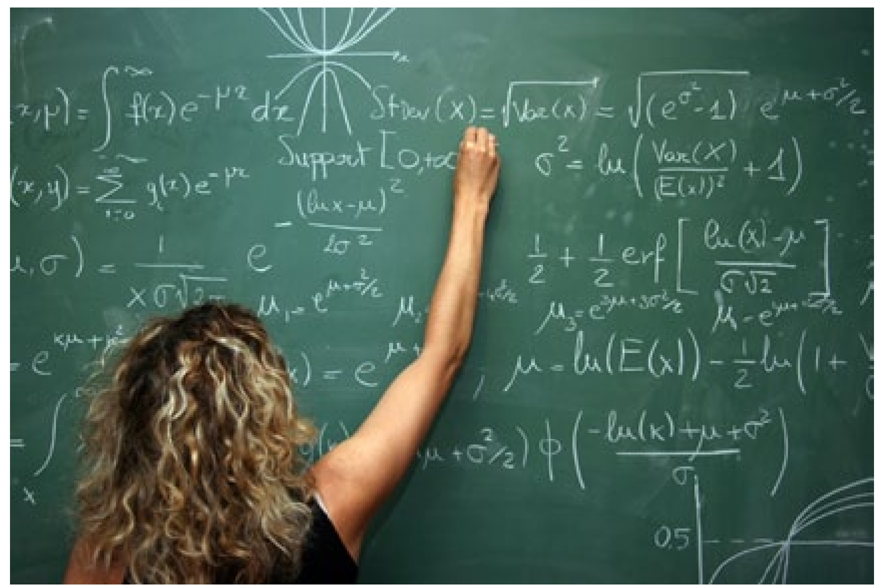
$$10.45 + 9.60 = \frac{20.05}{2}\text{ ml} = 10.0\text{ ml}$$

Pre-Reading Stage: Vocabulary Skills

All learners require adequate mastery of discipline-specific vocabulary. From their reading, students integrate words into thoughts and understand the relationships among words. Teaching vocabulary strategies when students begin an activity or reading models the importance that they too must develop an independent vocabulary strategy for unknown words before approaching a reading activity. Students must not only understand the vocabulary, but retain it, as mathematics and science vocabulary introduced in the first nine weeks is followed throughout the entire year.

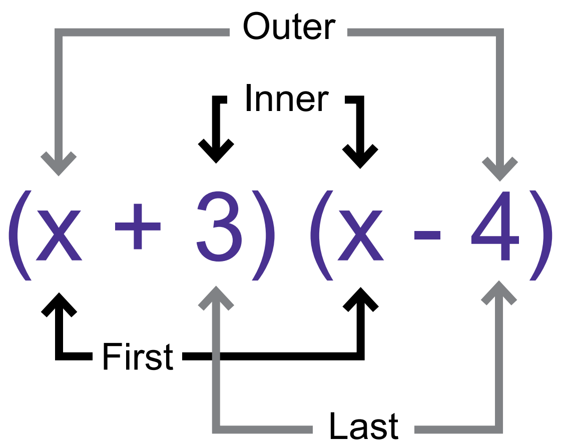
Importance of Vocabulary Skill Strategies

Without understanding the vocabulary of a given discipline, mastery of the underlying concepts is impossible. Vocabulary study is important because students must learn to read with precision. In mathematics and science, they cannot skip words or complete meaning from context as they can in narrative text; they must know the exact meaning of words. To do so, being able to employ vocabulary skills to understand complex vocabulary is crucial. In addition, many vocabulary words have different meanings mathematically than they do in conversational form, i.e. odd, power, etc.



Pre-Reading Stage: Vocabulary Skills

The STEPS alignment discussion presented multiple opportunities where vocabulary terms were not utilized appropriately. This inappropriate use of vocabulary in the short term may allow the student to complete the task but later inhibits understanding when the concept is applied in another situation. One such example involved the distributive property in which students are taught the mnemonic, FOIL.



FOIL method

When multiplying binomials like (x + 3) (x - 4) we should teach and use appropriate terms instead of mnemonics like FOIL. "FOIL", which stands for "First-Outer-Inner-Last", is a memory device.

The FOIL method works when multiplying two binomials but does not when multiplying more than two or larger sums. Therefore, when students are confronted with problems that are not pairs, they are often lost in how to solve the problem.

We compute this product using the distributive property twice.

First Application $(x + 3)(x - 4) = (x + 3)*x - (x + 3)*4$

Second Application $x^2 + 3x - 4x - 3*4$

(SFA Mathematics Faculty)

Pre-Reading Stage: Vocabulary Skills

Connecting Vocabulary Skills to the College and Career Readiness Standards

The Cross-Disciplinary Standards, Reading Across the Curriculum, address this skill directly as the student needs to posses and to use a variety of strategies to understand the meaning of new words. The science standards include this skill as recognizing and using scientific vocabulary in the field of study. Although the Mathematics Standards do not address vocabulary skills, they infer such in the Communication and Representation sections with the ability to accurately use language, terms, and symbols.

The vocabulary section will address three strategies.

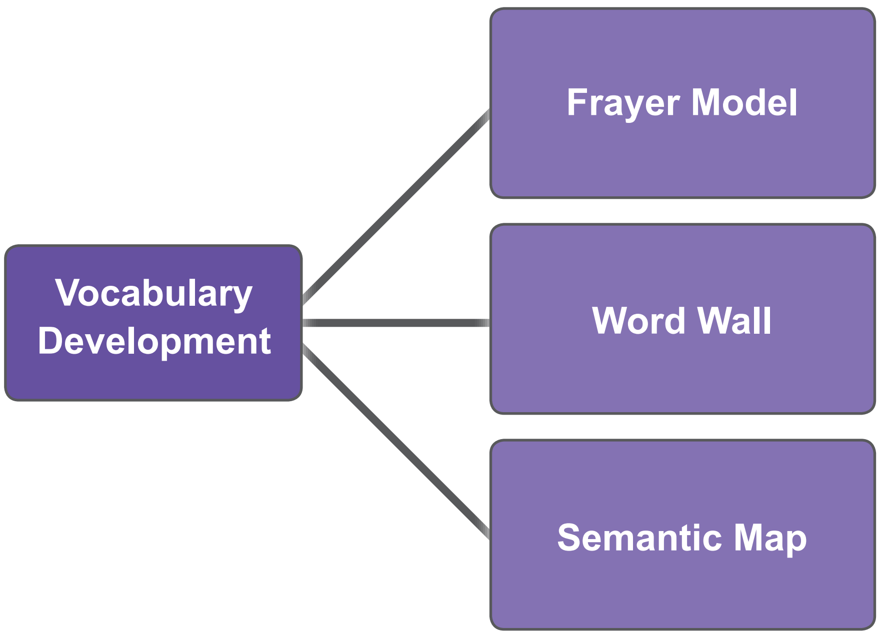
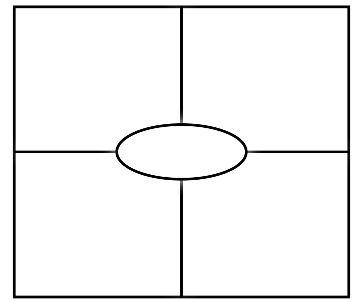
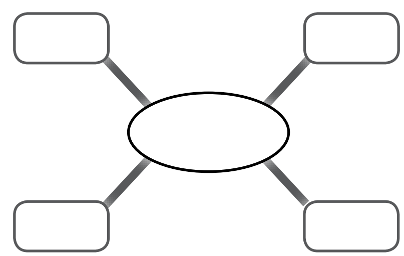


Figure 5





Frayer Model

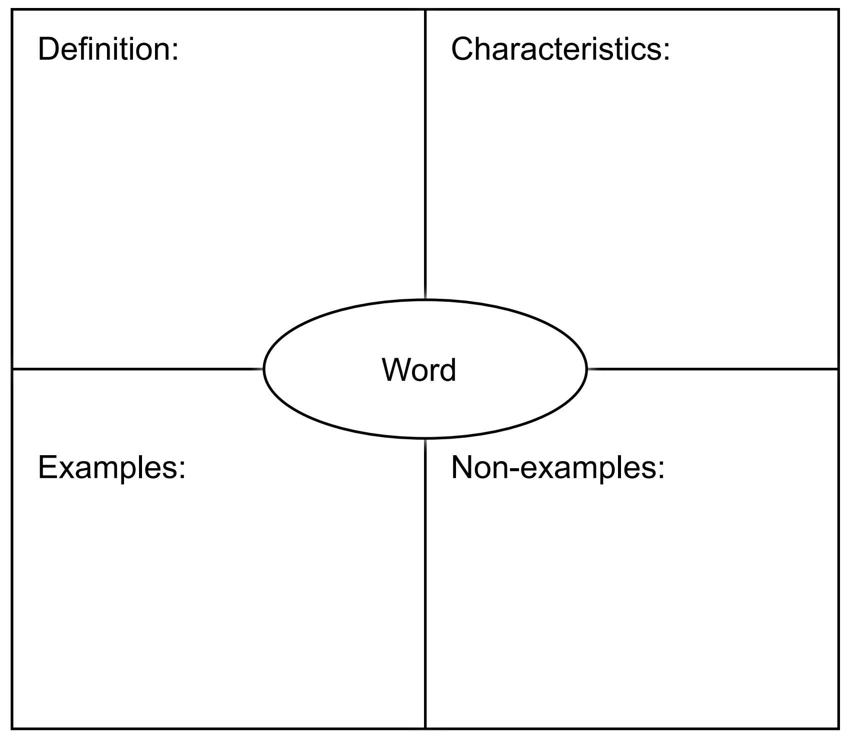
There are many concepts that can be confusing because of their close relationships. The Frayer model provides students with the opportunity to understand what a concept is and what it is not. It is a categorical system that aids students in understanding words or concepts. It gives students an opportunity to explain their understanding and to elaborate by providing examples and non-examples from their own lives.

The teacher introduces the model and how to fill out the diagram. The students then take a *new word or concept* and provide a *definition, characteristics, examples, and non-examples*.

The strategy can be utilized as a classroom activity or individually.

- Assign a concept that might be confusing because of its relational qualities
- Explain Frayer model
- Model how to fill out the graphic organizer

(Barton and Heidema, 2002, p. 77)



"The Frayer model provides the teachers with a quick look at the student's understanding and connection through their communication."
(STEPS team)

Mathematics Example: Building Vocabulary Skills

Content Objective: Function

A quadratic function is a function f if $f(x) = ax^2 + bx + c$, where a, b, and c are real numbers with $a \neq 0$. The graph of a quadratic function is called a parabola. The lowest or highest point of the parabola is called the vertex. To find the x intercepts, you would solve the equation $ax^2 + bx + c = 0$ by using the Quadratic formula or factoring.

The student would read the information and then utilize the Frayer model to chart the relationships.

Quadratic Function

Definition:	Characteristics:
A function f is a quadratic function if $f(x) = ax^2 + bx + c$, where a, b, and c are real numbers with $a \neq 0$.	• Parabola • Vertex • Intercepts • Quadratic Formula
Examples:	**Non-examples:**
• $f(x) = x^2 - 8x + 10$	• $F(x) = x^3 - 10$ • $F(x) = x^3 - x^2 + x + 7$

Science Example: Building Vocabulary Skills

Content Objective: Cells

Prokaryote

A prokaryote is a simple one-celled organism that does not have a true nucleus. Organisms with nuclei, either one-celled or multi-celled, are termed eukaryotes. Prokaryotes are much smaller than eukaryotes and have simpler biochemistry. These cells have few internal structures that are distinguishable under a microscope. Bacteria and cyanobacteria (also known as blue-green algae) are prokaryotes.

Bacteria are prokaryotes and are only about one to five microns in size. Most one-celled eukaryotes are at least 10 times larger than that. Lactobacillus and Salmonella are bacteria. Amoeba, Paramecium, and Euglena are eukaryotes. Multicellular eukaryotes include plants, fungi, algae, and animals such as humans, worms, and insects.

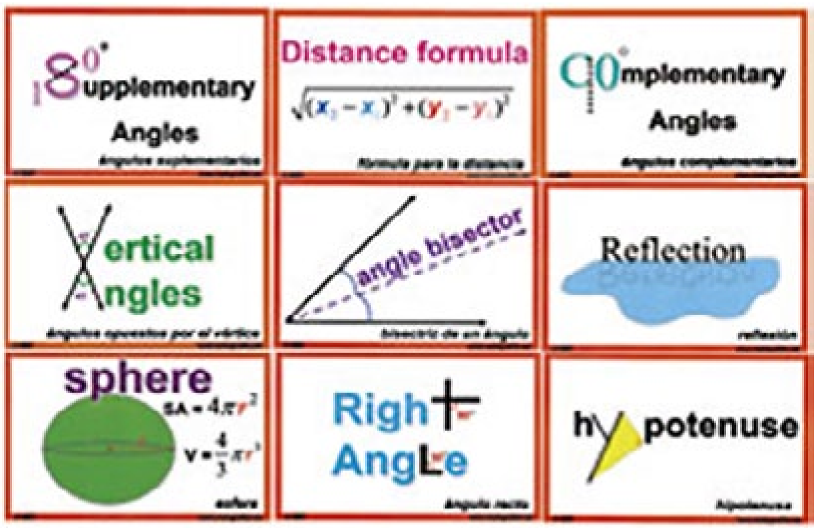
Definition: A simple one-celled form without a true nucleus	Characteristics: • Unicellular • No true nucleus • have simple biochemistry • most are 1-5 microns in size
Prokaryote	
Examples: • Bacteria like *Salmonella* • Blue green algae	Non-examples: • Eukaryotes • *Amoeba* • Humans • Worms • Viruses

(AC Biology Faculty)

Word Wall

After terms have been defined and used in classroom studies, retention may be improved through the use of games and classroom reminders. Word walls are dedicated spaces in the classroom where teachers and/or students can write or display words that are important, difficult to remember, or frequently missed. The words can remain on display as long as necessary.

Word sorts can also be utilized to assist students in recognizing the relationships among key concepts. Figure 4 provides an example of an geometry and biology word wall.



(Geometry Word Wall, Farmington Municipal Schools)

(Woden High School Biology Teacher)

Figure 4

Word Walls

Our STEPS teachers list all words in the assignment that may be important for students to understand. They arrange the words to show the relationships to the learning task. They may also add words that students probably already understand to connect relationships between what is known and what is unknown. They also attest that word walls are effective for the English Language Learner.

> *"As a science department, we have agreed upon a common vocabulary core used in all science classrooms that compose part of our word wall. For the specific science, we have agreed upon additional words that are added to the wall."*
>
> *(Lufkin HS Science department)*

Strategy: Pre-Reading Stage - Vocabulary

Semantic Maps

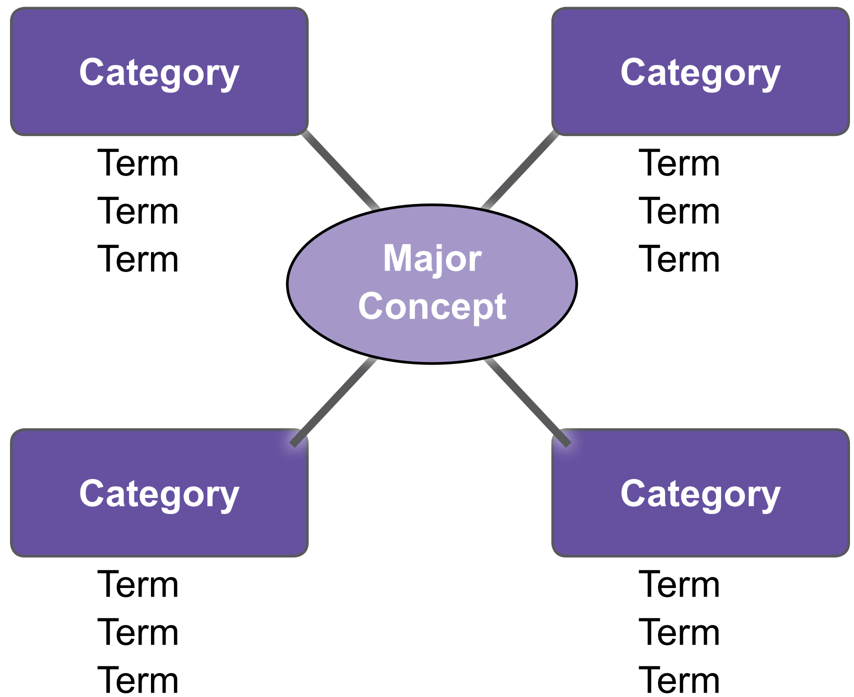
A semantic map is a tool that helps readers activate their prior knowledge and see the important components of concepts, along with forcing them to recognize the relationships between and among components.

The tool, as shown in Figure 6, can be used to introduce the topic and then can be used throughout the unit or series of lessons. This tool assists students in visualizing how terms are connected.

The strategy can be utilized as a classroom activity or individually.

- The topic is written on paper.
- The student(s) will brainstorm a list of terms that relate in some way to the topic.
- The student(s) will write the major topic in the center of a sheet of paper and circle it.
- The student(s) will review their brainstorm list and begin to categorize terms. The terms or categories are to be displayed in the map or web.
- The chart can be referred to and added to throughout the unit.

  (Barton and Heidema, 2002, p. 77)



(Barton and Heidema, 2002, p. 78)

Figure 6

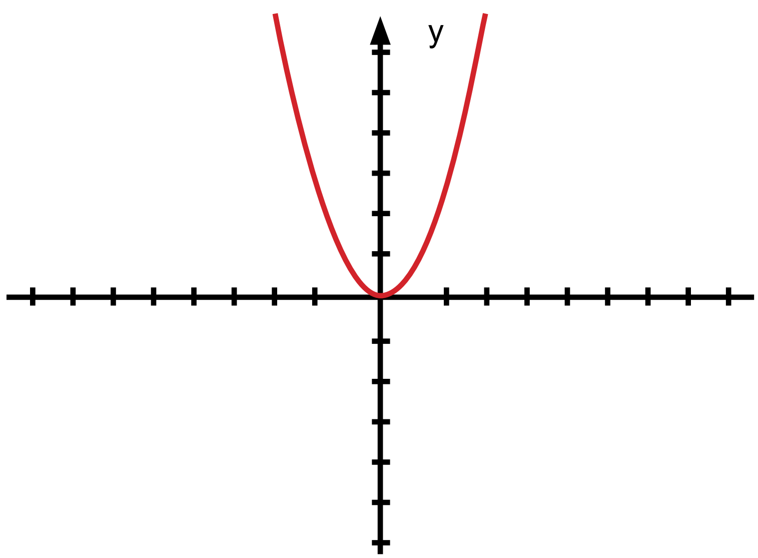
Mathematics Example: Building Vocabulary Skills

Content Objective: Function

A relation is a set of inputs and outputs, often written as ordered pairs (input, output). We can also represent a relation as a mapping diagram or a graph. A function is a special type of relation in which each input has only one output. In the relation, *y* is a function of *x*, because for each input *x* there is only one output *y*. The domain of a function is the set of all inputs and the range of a function is the set of all outputs of that function.

There are many ways to describe or represent a function. Relations and functions can be represented by equations such as $y = mx + b$, and $Ax + By = C$ (linear), $y = ax^2 + bx + c$ (quadratic), and $y = x^3$ (cubic).

There are special functions, such as constant, greatest integer, absolute value, square root, and rational that we will also explore. You can determine if the relation is a function from the coordinates or from the graph. To check if a relation is a function, given a mapping diagram of the relation, use the following criterion: if each input has exactly one line mapping to an output, then the relation represents a function. To determine whether y is a function of x, given a graph of a relation, use the following criterion: if every vertical line you can draw goes through only one point on the graph, y is a function of x. If you can draw a vertical line that goes through two points, y is not a function of x. This is called the Vertical Line Test.



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Mathematics Example: Building Vocabulary Skills

Content Objective: Function

Function

Function Test and Notation
- Vertical line test
- Function notation f(x)
- Mappings

Function Terms
- Domain
- Range
- Zero Slope
- Slopes
- Undefined Slope

Special Functions
- Constant
- Greatest Integer
- Quadratic
- Absolute Value
- Square Root Rational

Graphing
- Coordinates
- Linear
- Quadratic
- Cubic

Equation Form
- $y = mx + b$
- $Ax + By = C$
- $y = ax^2 + bx + c$

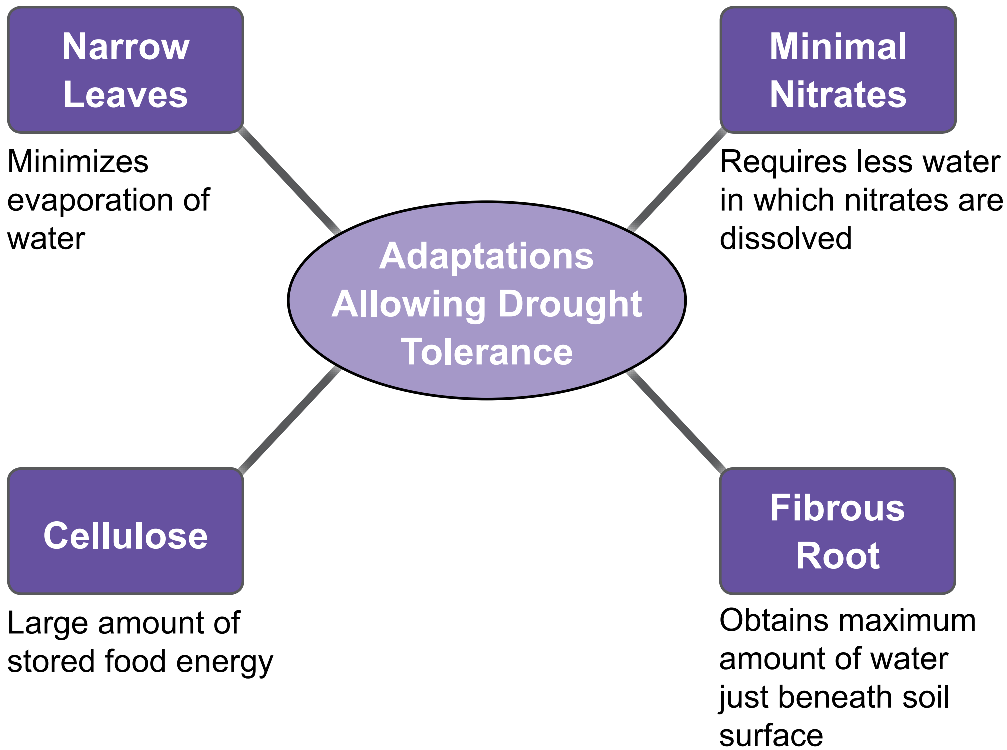
(Nacogdoches HS Algebra Teacher)

Science Example: Building Vocabulary Skills

Content Objective: Natural Selection

Agriculturists' interest in native Buffalo Grass has increased during recent years of drought. When herds of buffalo moved through Texas, this grass was plentiful. The grass has narrow leaves containing large amounts of cellulose and very low water content. Its fibrous roots run deep and require very little nitrate to maintain its slow growth. Ranchers want to know the results of recent field trials for its use as forage.

Explain how the characteristics of Buffalo Grass allow it to be drought tolerant.



Final Thoughts on Pre-Reading

Many of the strategies included in this module engage students in scaffolded (modeled) discussions of key content area concepts of mathematics and science.

The pre-reading stage should have strategies for teachers to appraise prior knowledge and evaluate the acquisition of content based on students' knowledge.

Teaching text features, prior knowledge strategies, and vocabulary reduce students' uncertainty of math and science and provide a purpose for the lessons being taught.

The During-Reading Stage: Its Connection to CCR

Exploring the During-Reading Stage for Mathematics and Science

In the during-reading stage, the student should be accessing the material questioning, justifying, predicting, reading, and re-reading a difficult text. The processing and reprocessing in the during-reading stage assists students to become critical readers.

Importance of the During-Reading Stage
This stage helps students distinguish important ideas from less important ideas, enables students to perceive relationships between concepts or ideas, helps students interact with the text and construct meaning, and keeps students on task.

The processing and reprocessing in the during-reading stage assists students to become critical readers.

Although there are many during-reading strategies, this section will only address text structure, note taking, and the Think Alouds strategy as noted in Figure 7.

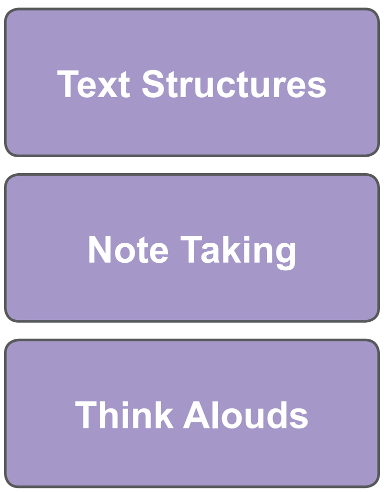


Figure 7

Exploring the During-Reading Stage for Mathematics and Science

Connecting the During-Reading Stage to the College and Career Readiness Standards
In the Cross-Disciplinary Standard, reading across the curriculum, it directly addresses during-reading strategies that students need to possess. These include identifying key information and supporting ideas, analyzing text critically, and adapting reading strategies according to text structure.

The Science Standards, Foundational Skills, also specify that students should be able to use during-reading strategies, including predicting text, self-questioning for understanding, and self-monitoring. Learn more about Cross-Disciplinary Standards and Science Standards.

During-Reading Stage: Text Structure

Text Structure refers to how the ideas in a text are interrelated to convey a message to a reader. Text structure relates to ways in which sentences, paragraphs, and the entire text are organized.

Teachers need to understand that students see a variety of text structures throughout their day. Some are capable of differentiating the organization and applying alternate strategies while others need direct instruction. Teaching students expository text structure will enhance their success with mathematics and science text.

There are two primary categories of text structure: narrative and expository. While the narrative includes themes, settings, plot, characters, a high point, and a resolution, the expository informs, explains, describes, gives directions, provides sequence, and provides arguments. This module will only deal with **expository text** because it is the organizational pattern used for mathematics and science to explain, describe, and give information.

Importance of Text Structure

As readers interact with the text to build meaning, their comprehension is enhanced when they organize their thinking patterns in a manner similar to that of the author.

This section will address the expository text structures noted in Figure 8. Extensive information can be found online.
Expository Text Structure.

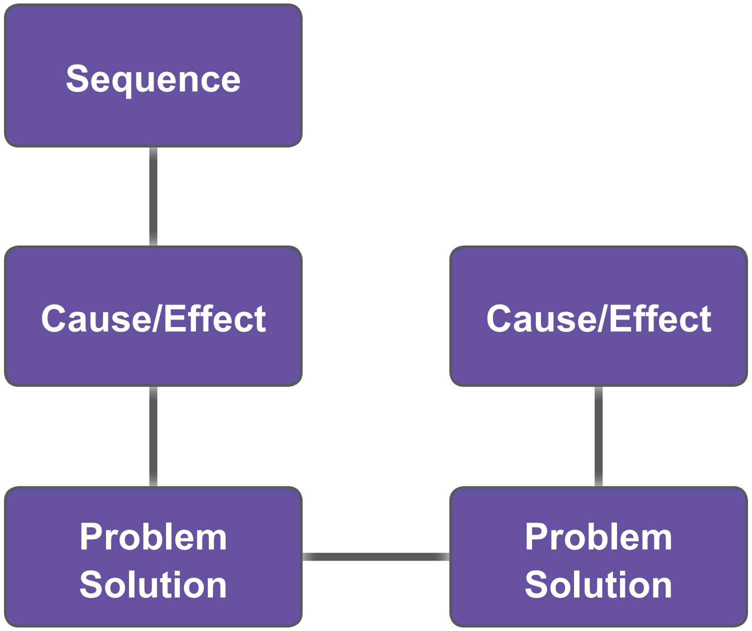


Figure 8

During-Reading Stage: Text Structure

Importance of Teaching Expository Text Structure

Teaching students strategies for an expository text structure enhances their comprehension. Often, they are unable to see the big picture because they become lost in the words. They also are confused by the technical nature of an expository text when the topic is unfamiliar and there is new vocabulary. Readers who can understand the different patterns writers use to compose expository text structures and use this knowledge when reading typically understand and remember what they read.

Often, multiple text structures are presented during a student's day of instruction, so it behooves the teacher to instill strategies that students can employ when confronting different expository text structures.

Strategy: During-Reading Stage - Text Structure

Sequence

The term "sequence" suggests a flowchart or sequence of steps. The information is to be listed in the order in which it occurs. A **sequence structure** can refer to the steps to follow in working out a mathematics problem.

The student reads the problem and determines that it is a **sequence text structure** when noting signal words, such as *afterward, later, finally, last, early, following, to begin with, as time passed, continuing on, in the first place, before, first, second, previously, then, since, more recently, soon, not long after* in the problem or passage.

Students will fill in information for the sequence graphic organizer, as noted in Figure 9, from the passage that allows engagement with the text, as well as determining what to do for each step of the problem. If they are recognizing text patterns, such as sequence, their perception of the text will improve, they can distinguish important concepts from misleading ones, and hopefully determine where they are making mistakes.

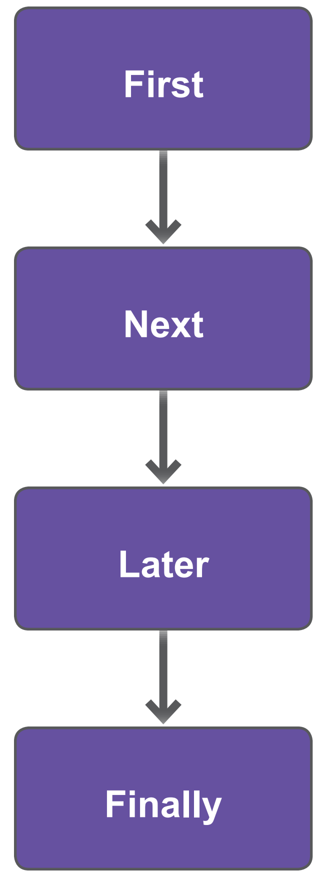


Figure 9

Mathematics Example: Sequence

Content Objective: Construction of a perpendicular bisector

To construct a perpendicular bisector, first start with a line segment AB. Next, place the compass on one end of the line segment setting the compass width wider than ½ of the length of segment AB. Then, draw an arc above and below the line segment. Holding the same radius on the compass, place the compass point on the other end of the line segment and draw arcs above and below the line segment that intersect the previous arcs. Finally, using a straight edge, draw a line between the points where the arc intersects.

Line segment

↓

Place compass on one end

↓

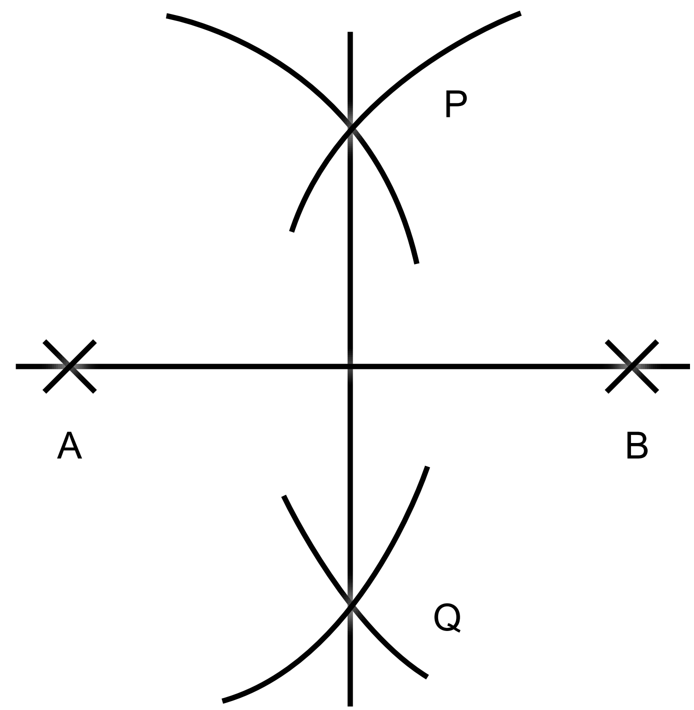
Draw arc above and below line

↓

Compass at other end, draw arc above and below

↓

Draw line between points arc intersection



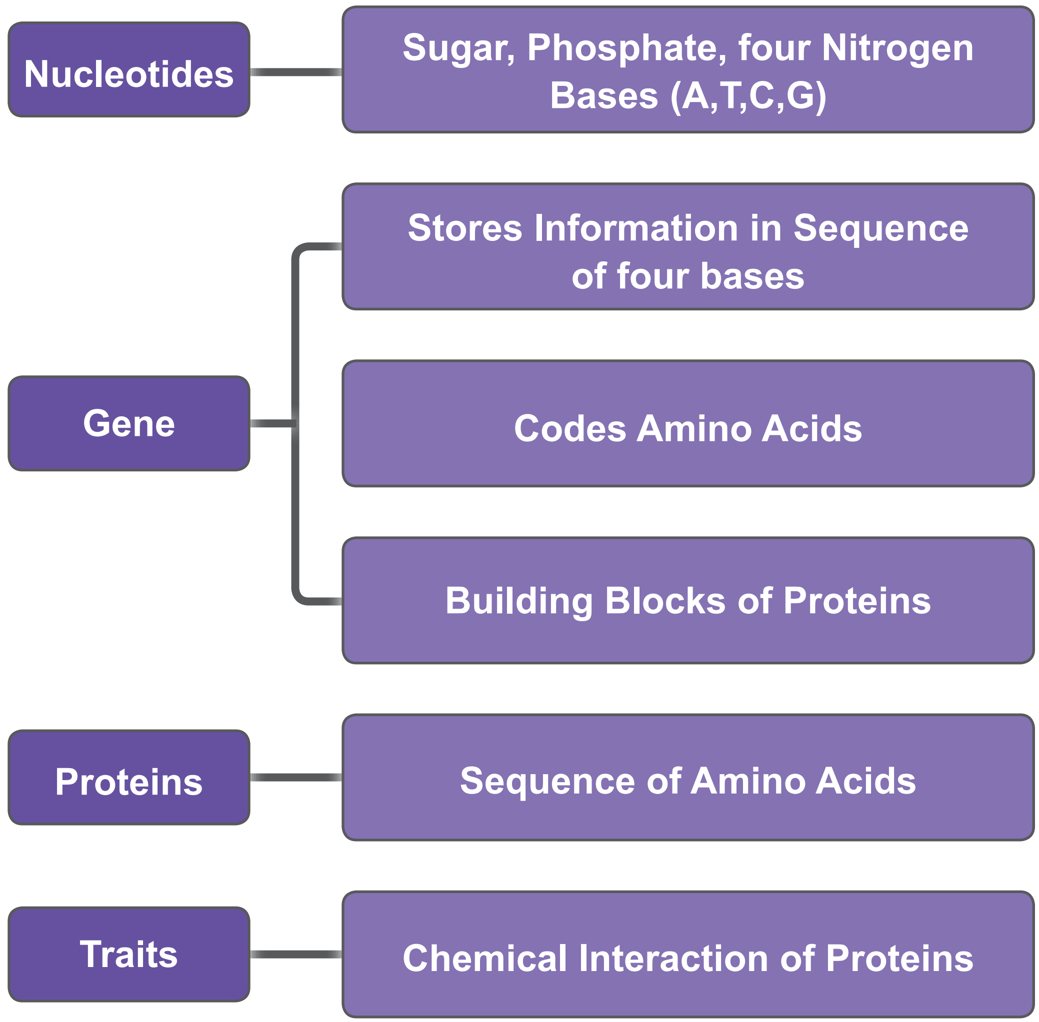
(STEPS HS Geometry Teachers)

Science Example: Sequence

Content Objective: DNA to Protein

DNA molecules are composed of building blocks called nucleotides, each of which are composed of a sugar, a phosphate group, and a nitrogen base. Because there are four different nitrogen bases, there are four possible nucleotides (A,T, C, G). All genetic information in DNA is stored in the sequence of the four bases. Each sequence is referred to as a gene, a section of DNA that encodes for the production of an end product, usually a protein.

Each gene codes for amino acids, which are the building blocks of proteins. There are only 20 amino acids, but the specific sequences of those amino acids make the many different proteins. The expression and interaction of proteins produces unique traits of an organism.



(Nacogdoches HS Biology Teacher)

Cause and Effect

In the cause and effect text structure, two or more ideas interact with one another. This pattern is commonly noted in high school history, science, and health text.

The **cause and effect text structure** could be as straightforward as Figure 8 with one event occurring as a result of the prior event; however, it can be much more complex as noted in Figure 9 with an event having several consequences.

The teacher has the student look for signal words, such as *for the purpose of, thus, if/then, therefore, because, as a result of, since, because, caused, led to, in order to, this is why, the reason, so, in explanation, nevertheless*, and complete the chart.

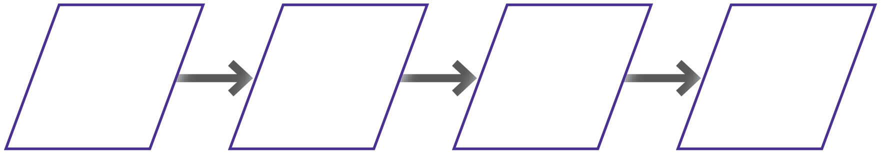


Figure 10

Students will fill in appropriate text in a graphic organizer similar to Figure 10 or 11, helping to determine an interaction between at least two ideas or events, one taking action and another resulting from that action.

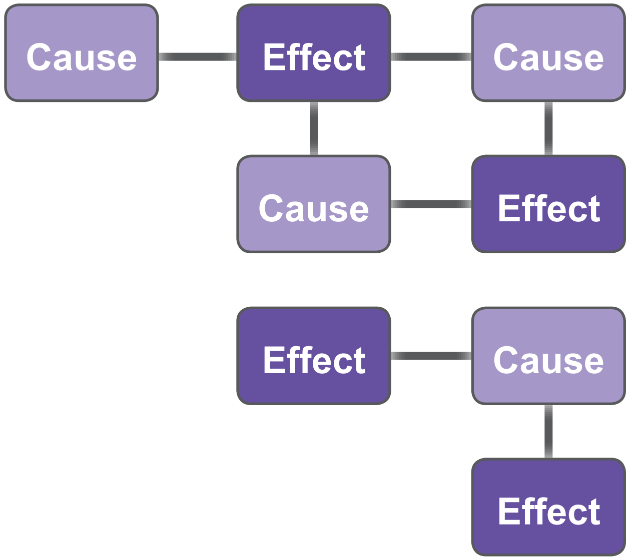


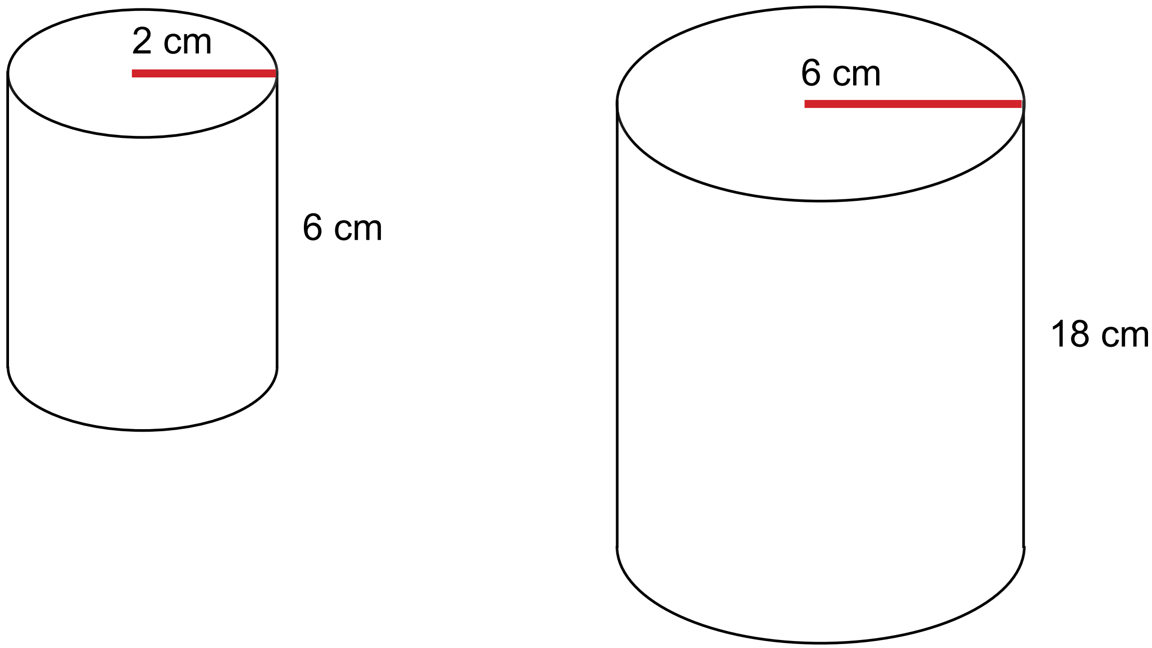
Figure 11

Using the cause-effect pattern, students will see how a single cause will have more than one effect and a single event may have more than cause.

Mathematics Example: Cause and Effect

Content Objective: Dimensions in volume of a cylinder

The smaller cylinder has a radius of 2 cm and a height of 6 cm. If the radius is increased to 6 cm and the height is increased to 18 cm, describe the effect on the volume.



Cause - radius and height increase by 3 times → **Effect-volume increased by 27 times**

(Nacogdoches HS Geometry Teacher)

Science Example: Cause and Effect

Content Objective: Gas Laws

Boyle's Law

If you trap a sample of air and measure its volume at different pressures (constant temperatures), then you can determine a relation between volume and pressure. If you do this experiment, you will find that as the pressure of a gas sample increased, its volume decreases. In other words, the volume of a gas sample at constant temperature is inversely proportional to its pressure. The product of the pressure multiplied by the volume is a constant.

$$pv = k \quad \text{or} \quad \frac{v = k}{p} \quad \text{or} \quad \frac{k}{v}$$

A sample of helium gas at 25^0 is compressed from 200 cm^3 to .240 cm^3. Its pressure is now 3.00 cm Hg. What was the original pressure of the helium?

Initial		Final
P_1 = ?; v, = 200 cm^3, n, = n; T_2 = T	→	3.00 cm Hg; V_2 = .240 cm^3; n_2 = n; T_2 = T

$$P_1 = \frac{P_2V_2}{V_1}$$

$$P_1 = \frac{3.00 \text{ cm Hg} \times 0.240 \text{ cm}^3}{200 \text{ cm}^3}$$

$$P_1 = 3.60 \times 10^3 \text{ cm Hg}$$

Problem-Solution

The **problem-solution text structure** describes a problem and suggest one or more solutions to the problem. Typically, the problem is explained, solutions are then presented, and the problem is solved, partially solved, or not solved.

The student reads the problem and determines that it is a problem-solution text structure when noting some of the following signal words for the problem: *question, perplexity, the trouble problem-question, the dilemma , issue, or need to prevent. Solution-answer, reply, response, return, comeback, to satisfy the problem, or to solve this problem.*

As students encounter problem-solution text patterns, they will again see an interaction between at least two factors, one citing the problem and another providing a potential answer to that problem.

Once the student determines that it is a problem-solution structure, he/she will complete a graphic organizer, such as noted in Figure 12 or 13, to help guide understanding.

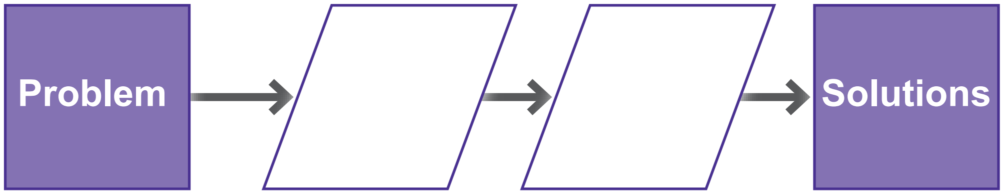


Figure 12

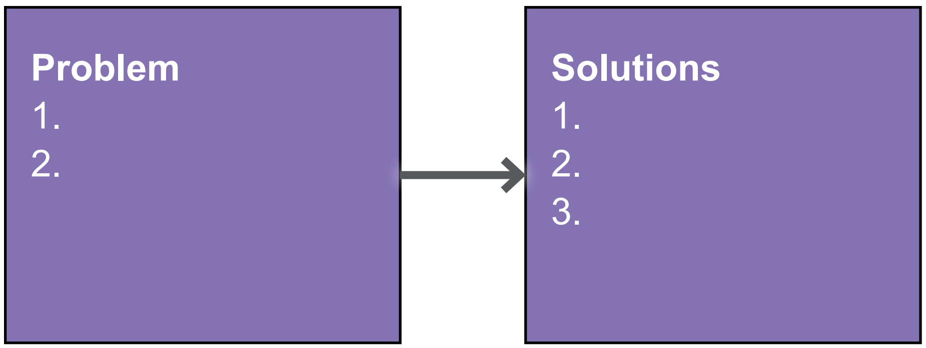


Figure 13

Mathematics Example: Problem-Solution

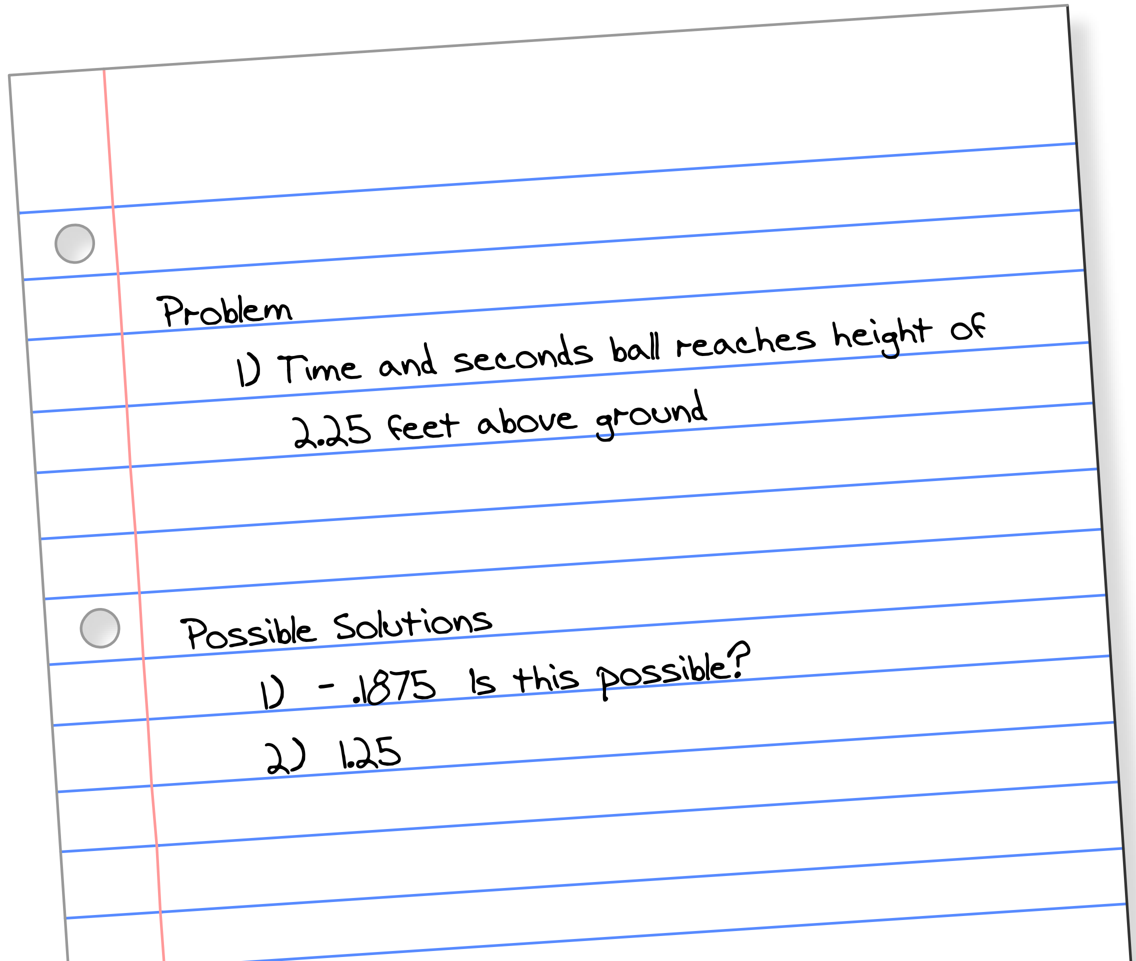
Content Objective: Quadratic Function

The function $h(t) = -16t^2 + 17t + 6$ can be used to determine the height, $h(t)$, in feet of a super ball t seconds after it is thrown upward from a window on the first floor.

At what time does the ball reach a height of 2.25 feet above the ground?

Student is to:

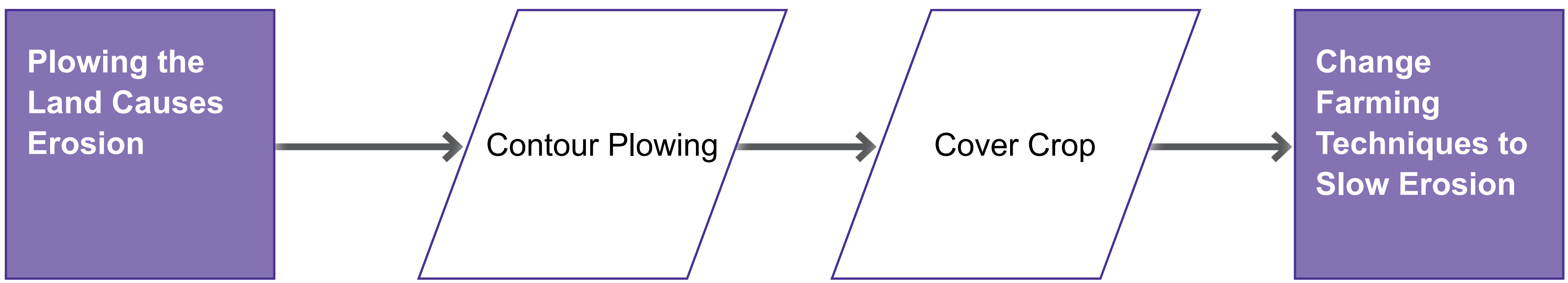
- Identify the problem and solutions
- Justify the solution in writing



Science Example: Problem-Solution

Content Objective: Environmental Change and Ecosystem Stability

Much agricultural land in the American Midwest was once covered by prairie ecosystems that produced and maintained a meter or more of very fertile topsoil. Plowing the land removes the roots that held the soil in place. This increased the rate of soil erosion. However, sustainable development practices can guard against these problems. One practice is continuous plowing, in which fields are plowed across the slopes of the land. Another strategy involves leaving the stems and roots of the previous year's crop in place and planting rye, a cover crop, rather than leaving it unprotected from erosion.



Compare and Contrast

The **compare and contrast text structure** refers to texts that involve comparing and contrasting descriptive information. Typically, the reader will see a focus on similarities and differences.

The student reads the problem and determines that it is a **compare and contrast text structure** when noting signal words, such *similar, like, unlike, on the other hand, also, too, different, in the same way, just as, likewise, in comparison, also, on the other hand, or yet*.

Students will list similarities and/or differences among two or more things, such as *mean, median, and mode* in a mathematics text.

Once the student determines that it is a compare and contrast structure, he/she will complete a graphic organizer, such as noted in Figure 14, to help guide understanding.

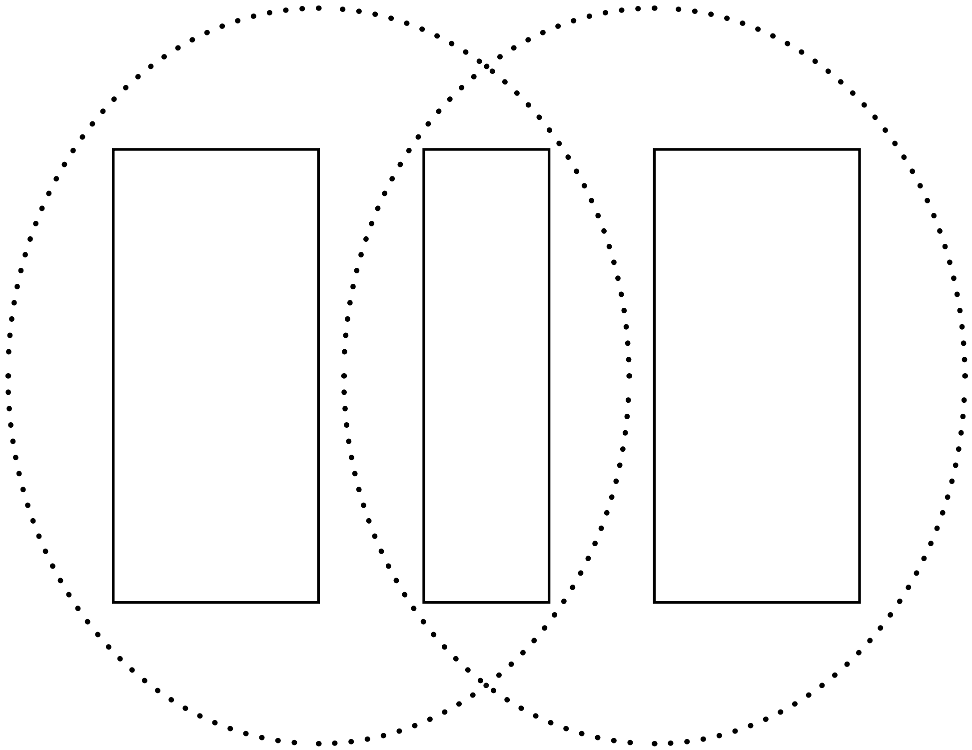


Figure 14

Mathematics Example: Compare and Contrast

Content Objective: Polynomial function

A polynomial function is a relationship whose equation can be expressed in the form: Y = an expression that is constructed from one or more variables and constants, using only the mathematical operations of +, -, * and constant whole number exponents. Determine from the following activity what and why some functions are considered polynomials and some are not. Learn more about Polynomial Functions.

Polynomials

- Whole number exponents
- No division with variables in denominator
- Continuous graph
- All are functions

Both

- Variables
- Multiply, add, subtract whole numbers
- Fractions

Non-Polynomials

- Rational exponents
- Division with variables in denominator
- Radical equations
- Graphs with gaps
- Some graphs are not functions

(Hudson HS Algebra Teacher)

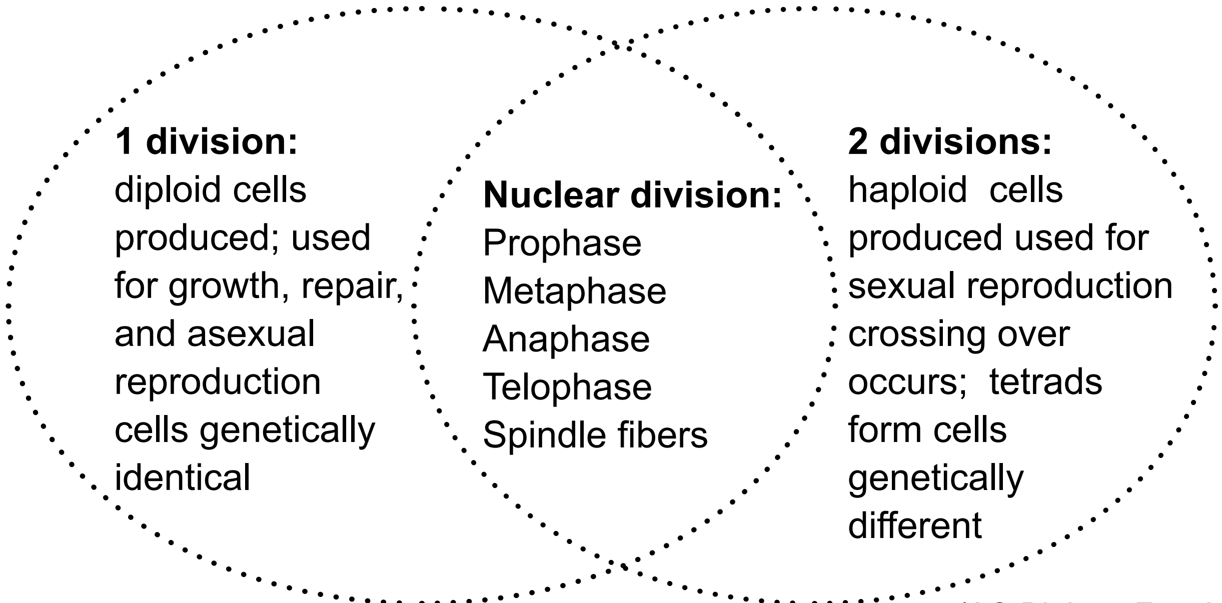
Science Example: Compare and Contrast

Content Objective: Mitosis and Meiosis

Mitosis and meiosis are two forms of nuclear division that typically occurs during the process of cell division. Each is composed of a series of steps (prophase, metaphase, anaphase, and telophase). The primary events in those steps are similar between the two types of divisions, though several differences also occur. Mitosis is primarily responsible for the growth and repair of an organism's tissues. Meiosis allows sexual reproduction to occur by reducing the number of chromosomes in reproductive cells, such as the egg and sperm.

In most organisms, normal body cells contain two copies of each chromosome. Thus, they are said to be diploid. Mitosis divides one parent diploid cell into two genetically identical diploid cells. These daughter cells are essentially copies of the original parent cell. Meiosis occurs within one original diploid parent cell and will end up producing four genetically different haploid cells. These haploid cells only contain one copy of each chromosome.

To generate these four cells, there are two nuclear divisions that comprise the process of meiosis. Each of these divisions consists of the same steps: prophase, metaphase, anaphase, telophase. Since each step happens twice, roman numerals are used to identify if the step is in the first or second division (prophase I versus prophase II).



(AC Biology Faculty)

Strategy: During-Reading Stage - Text Structure

Descriptive

The **descriptive text structure** focuses on the characteristics or attributes of something.

Figure 15 presents a web approach for the **descriptive text structure** with clustering bits of information about one topic.

The teacher teaches the student to look for signal words, such as *spatial words, next to, on top of, beside, for example, characteristics, such as, is like, including, attributes of , that is, marks of, in describing, or to illustrate*.

Students will look for traits, functions, or properties in the descriptive text patterns and complete a graphic organizer, such as noted in Figure 15. This will enable students to determine more important ideas from less important ideas.

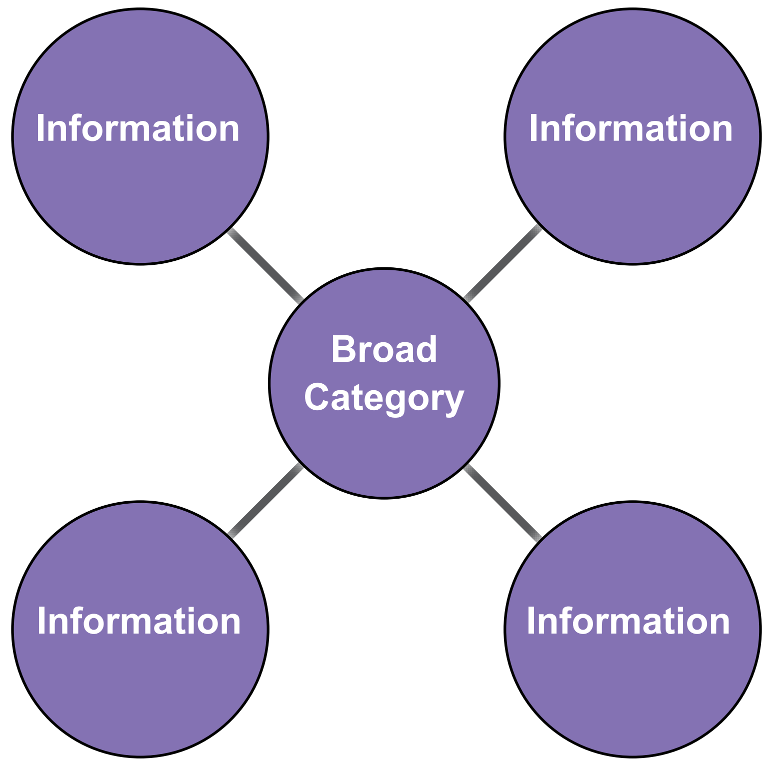


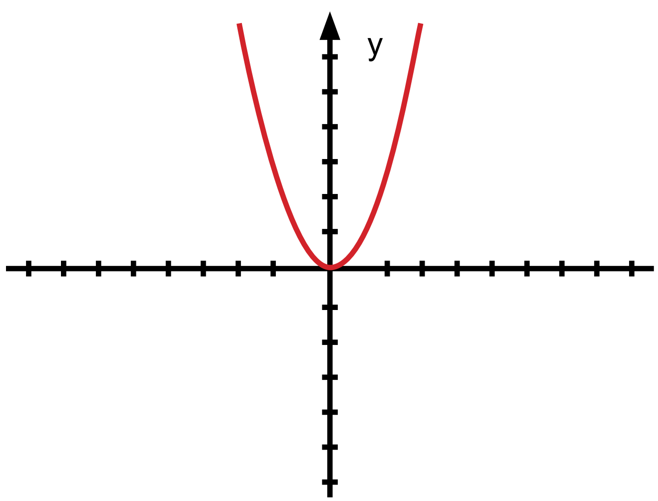
Figure 15

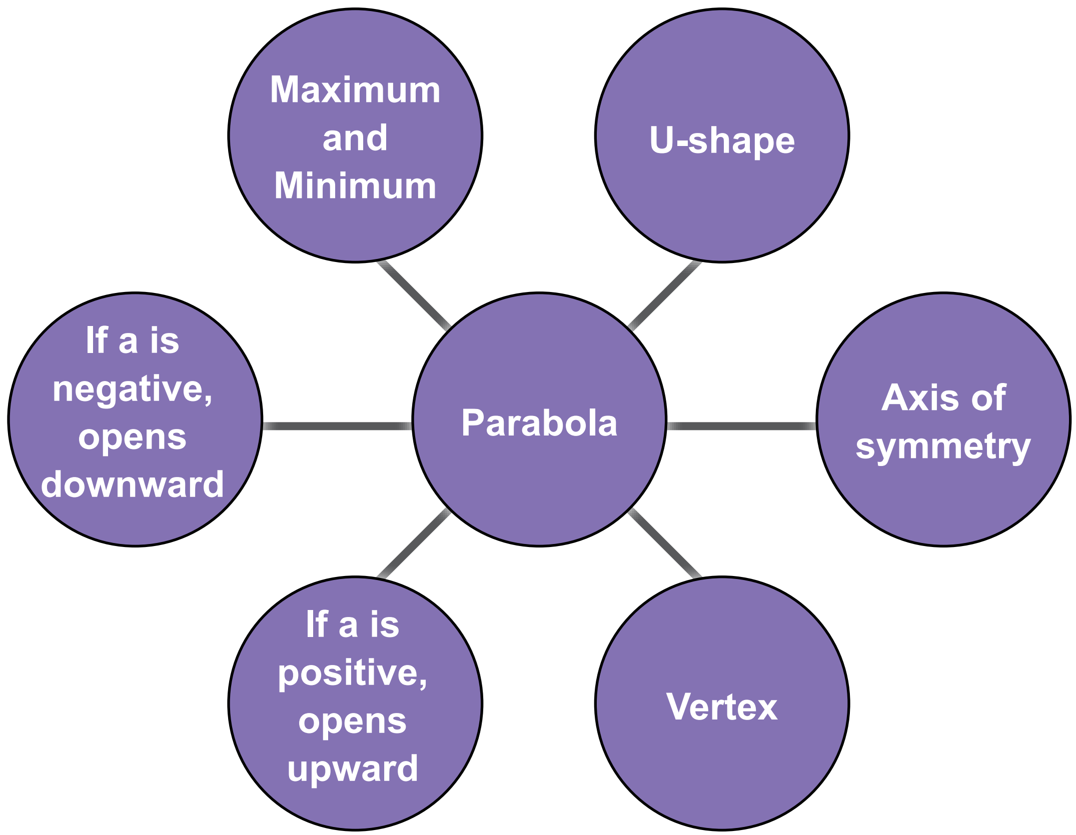
Mathematics Example: Descriptive

Content Objective: Quadratic Function

Parabolas

The graph of a quadratic function is called a parabola. The graphs of all parabolas have the same general U-shape. Line (axis) of symmetry is the line about which the parabola is symmetrical. The vertex is the lowest (minimum) or highest (maximum) point of a parabola. All quadratic functions can be expressed either in vertex form $y = a(x - h) + k$ or in standard form $y = ax^2 + bx + c$. When quadratic equations are written in vertex form, (h,k) identifies the vertex of the parabola. The line of symmetry is $x = h$. In vertex form, a affects the direction the parabola opens and how wide or narrow it will open. If a is negative, the parabola will open down. If a is positive, the parabola will open upward.





Science Example: Descriptive

Content Objective: Properties of Water

Many of water's unique properties are largely a result of its chemical structure. When the hydrogen atoms combine with oxygen, they each share their single electron and form a covalent bond. Because electrons are more attracted to the positively charged oxygen atom, the two hydrogen atoms become electronegative oxygen and the oxygen atom becomes negatively charged. This separation between negative and positive charges produces a polar molecule, which is a molecule that has an electrical charge on its surface.

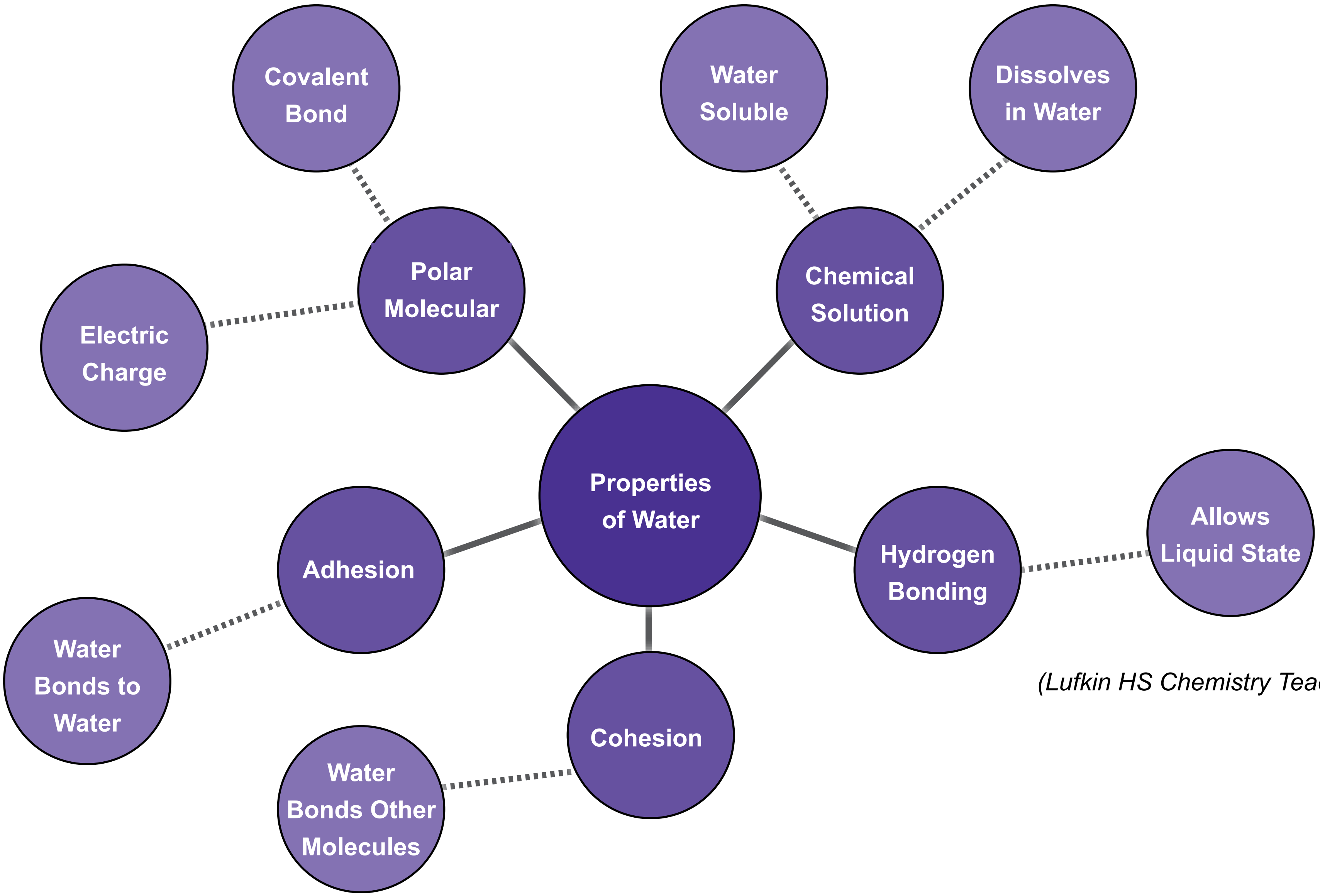
The hydrogen lobes have positive charges and the oxygen atom on the opposite side has two negative charges (associated with two lobes). The net interaction between the covalent bond and the attracting and repulsion between the positive and negative charges repelling charges produces the 'V' shape of the molecule. The polarity of water allows it to bind with itself, cohesion, and to other molecules, adhesion.

This ability to attract other molecules allows many substances to dissolve in water, which means they are water soluble, and produces chemical solutions. The water molecules form hydrogen bonds among themselves giving shape to water as a liquid.

Continued on next page...

Science Example: Descriptive

Content Objective: Properties of Water



(Lufkin HS Chemistry Teacher)

During-Reading Stage: Note Taking

Note taking is a postsecondary student expectation and an important strategy for college readiness and effective reading comprehension. There are many types and systems for note taking, but they all focus on developing a systematic method for depicting the main ideas of lectures and texts, utilizing symbols and abbreviations, documenting questions, and summarizing presented material.

Importance of Note Taking
For your students to be college and career ready, their success begins with being organized and ready to learn during a lecture, as well as when they are reading materials. Note taking helps them to be focused in class, organize the presented content, and provides a study guide.

The amount of information delivered by the professor and from extra readings demands that the student employ a workable, practiced note taking system.

This skill is also important for careers, as any meeting presents a wealth of information that requires one to determine salient points.

> *"Teachers must be very literal and model exactly what you want students to gain and apply from the note taking experience. Always have the student reflect on and summarize recorded notes. For biology, illustrations are a part of the notes."*
> (STEPS teachers)

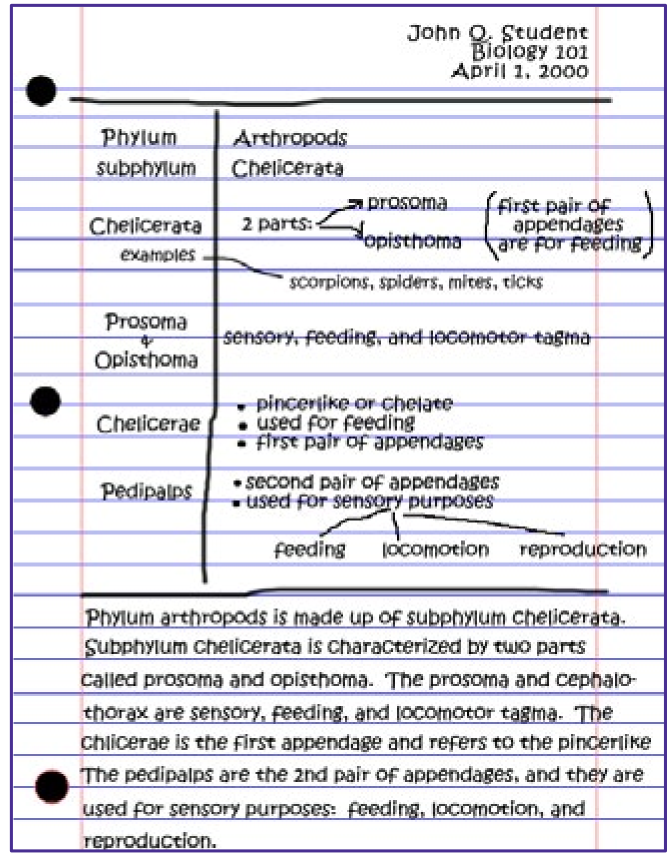
Strategy: During-Reading Stage

Note Taking

There are any number of resources for note taking strategies and systems. The teacher must choose a system, teach the strategy specifically, and set the student expectation. The primary purpose, however, is to have the student as the active learner in the note taking process and have a system that requires the student to reflect upon the notes.

Cornell Note Taking is a proven method. It provides a systematic format for organizing and condensing your notes. It teaches the student to divide the paper format into three sections and document the heading, as well as how to write, review and clarify, summarize, and ultimately how to study your notes.

Figure 16 represents an example for a biology class from the Learning ToolBox. The following link provides a template example for Cornell Note Taking.



John Q. Student
Biology 101
April 1, 2000

Phylum	Arthropods
subphylum	Chelicerata
Chelicerata	2 parts: prosoma, opisthoma (first pair of appendages are for feeding)
examples	scorpions, spiders, mites, ticks
Prosoma + Opisthoma	sensory, feeding, and locomotor tagma
Chelicerae	• pincerlike or chelate • used for feeding • first pair of appendages
Pedipalps	• second pair of appendages • used for sensory purposes: feeding, locomotion, reproduction

Phylum arthropods is made up of subphylum chelicerata. Subphylum chelicerata is characterized by two parts called prosoma and opisthoma. The prosoma and cephalo-thorax are sensory, feeding, and locomotor tagma. The chilicerae is the first appendage and refers to the pincerlike The pedipalps are the 2nd pair of appendages, and they are used for sensory purposes: feeding, locomotion, and reproduction.

(Learning Tool Box, n.d.)

Figure 16

"Our #1 recommendation, show them how.

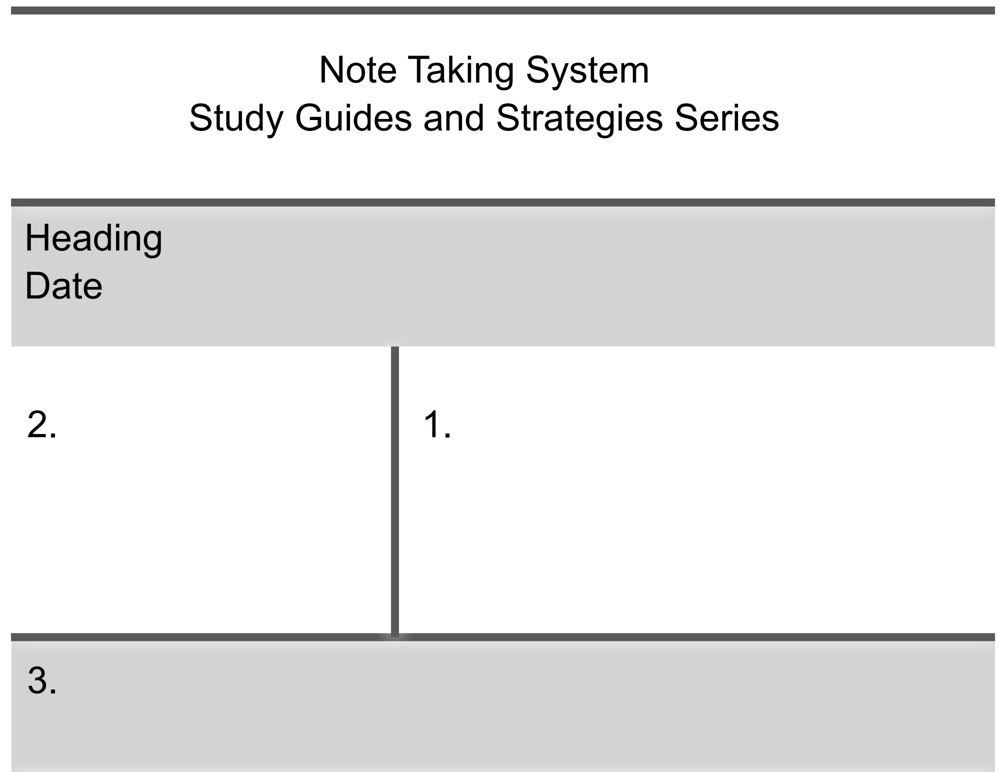
- Teach the student to list all issues that he/she does not understand in the left-hand margin of any note taking system. This will signal them to seek counsel or further clarification.
- Show them how to use their notes to study."

(*STEPS teachers*)

Note Taking

Study Guides and Strategies Series provides a 5 R system for note taking. Figure 17 provides the page set up for this system.

1. **Record:** Teach them to identify the main points capturing the main ideas. Encourage them to use outlines or concept maps.
2. **Reduce:** After class, have them summarize by identifying the key words, phrases, or questions. They can link to information from their textbook, Websites, or other sources that help them understand or study the material.
3. **Recite:** You teach them to Talk aloud! so they review from memory what they have learned using the left-hand margin's key words and questions, talk through, or illustrate definitions, concepts, etc.
4. **Reflect:** Teach them to relate the information to what they knew before.
5. **Review:** Teach them to review their notes.



(Study Guides and Strategies Series, n.d.)

Figure 17

During-Reading Stage: Note Taking

Our #1 recommendation, show them how

- Teach the student to list all issues that he/she does not understand in the left hand margin of any note taking system. This will signal them to seek counsel or further clarification.

- Show them how to use their notes to study.

During-Reading Stage: Think Alouds

Think Alouds is a metacognitive strategy in which the teacher verbalizes aloud while reading a selection, thus modeling the process of comprehension (vocabulary, connections, questions, etc.). The strategy provides insight into the **thinking processes** involved in reading.

Importance of Think Alouds

This strategy models to students what good readers do as they read. Once this process is modeled numerous times in a large group, students begin practicing this process themselves. This strategy provides processing and reprocessing of text which builds critical readers.

This strategy provides particular importance to the English language learner or struggling student, though it has value for all.

Strategy: During-Reading Strategies

Think Alouds

The teacher will model how to explore the mathematics or science text. It could include any aspect of a lesson. Our STEPS teachers suggest that when they model it, the strategy assists students with creating mental pictures and connecting learning to prior learning.

The teacher merely chooses a passage or problem, reads it aloud as the student follows, and verbalizes his/her thinking about the text or problem.

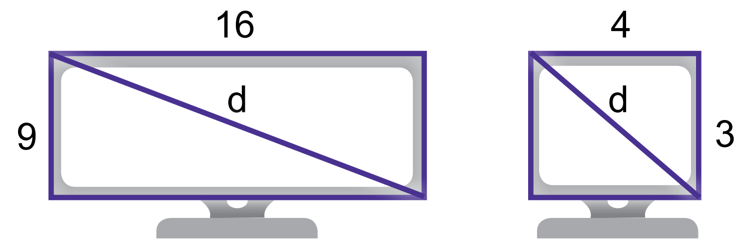
Mathematics Example: Think Alouds

Content Objective: Pythagorean Theorem

The Super Bowl is just weeks away and you have not bought a TV. You have decided that you really like the 42" screens, but you cannot decide between the traditional TV with its 4:3 width: height ratio or the newer HDTV which has a 16:9 width: height ratio. The cabinet that your TV has to go in is exactly 42" wide! At first you think you will have to downsize your TV to make it fit, but then you remember that TV screens are sized according to the diagonal length. You decide to determine if either 42" format will fit the cabinet.

Think Aloud

What is the difference in the two formats? I would draw a diagram of a 16:9 width: height ratio TV and the 4:3 width: height ratio TV.



Sketch the diagonals of the two models.

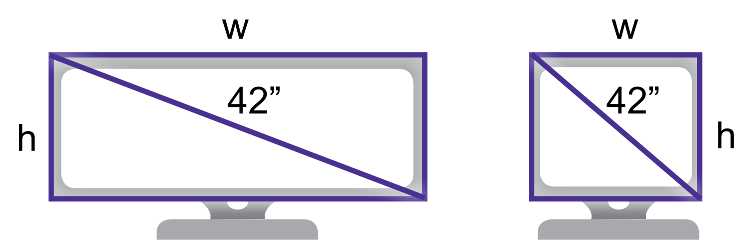
How would you find the length of the diagonals of the two models? (Pythagorean Theorem)

What I really want to know is will the TVs fit in my 42" wide cabinet?

These two models are proportional to the two actual TVs with diagonals of 42". I would draw pictures of the actual TVs.

I would use a proportion using the measurements of the model TV and the actual TV to find the width of both the TVs.

$$\frac{\text{Model width}}{\text{Model diagonal}} = \frac{\text{actual width}}{\text{actual diagonal}}$$



Now, which TV will fit in the 42" cabinet?

(Hudson Geometry Teacher)

Science Example: Think Alouds

Content Objective: Oxidation State

Oxidation State
Is a measure of the degree of oxidation of an atom in a chemical compound. The formal oxidation state is the hypothetical charge that an atom would have if all bonds to atoms of different elements were 100 percent ionic. The oxidation rules are:

1. The oxidation state of a free element is zero.

   Think Aloud
   The element is not in a compound, so it doesn't have an oxidation number.

2. For a simple (monatomic) ion, the oxidation state is equal to the net charge on the ion.

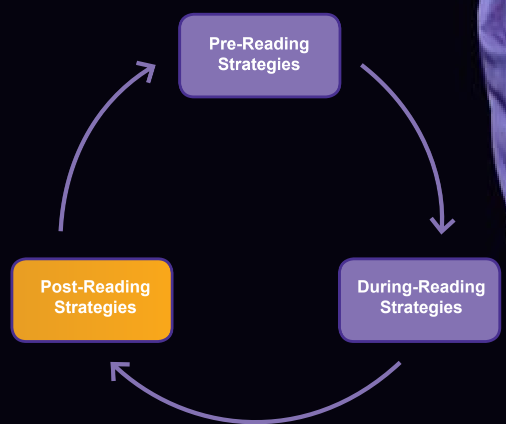
   Think Aloud
   An ion has taken at least one electron, making it have a negative charge.

   Think Aloud
   So Cl- has an oxidation of -1 since it can take on one electron with its negative charge.

Final Thoughts on During-Reading Strategies

During this interactive phase, students encounter new information. As teachers, we need to model strategies designed to help them process this information and/or generate new information from their own inquiry.

During-reading strategies help students search for information to satisfy the purposes set by the teacher and/or themselves, interact with text and construct meaning, as well as keep them on task.



The Post-Reading Stage: Its Connection to CCR

Exploring Post-Reading for Mathematics and Science

During the post-reading stage, the reader is justifying to confirm their questions, prediction, and thoughts. Post-reading activities allow students to reflect and connect. Graphic organizers assist students in organizing terms and concepts.

Importance of Post-Reading Strategies
Post-reading strategies help students:

- clarify and elaborate on ideas from text,
- extend thinking about ideas encountered in text,
- connect to other texts,
- process information, and
- put information into schema and long-term memory.

Connecting Post-Reading Stage to the College and Career Readiness Standards
In the Cross-Disciplinary Standard, Reading Across the Curriculum, it directly addresses post-reading strategies that students need to possess in identifying key information and supporting ideas, analyzing text critically, and adapting reading strategies according to text structure. The Science Standards, Foundational Skills, also specify that students should be able to use during-reading strategies, including predicting text, self-questioning for understanding, and self-monitoring.
Learn more about Cross-Disciplinary Standards and Science Standards.

As noted in Figure 18, this section will review three post-reading strategies:

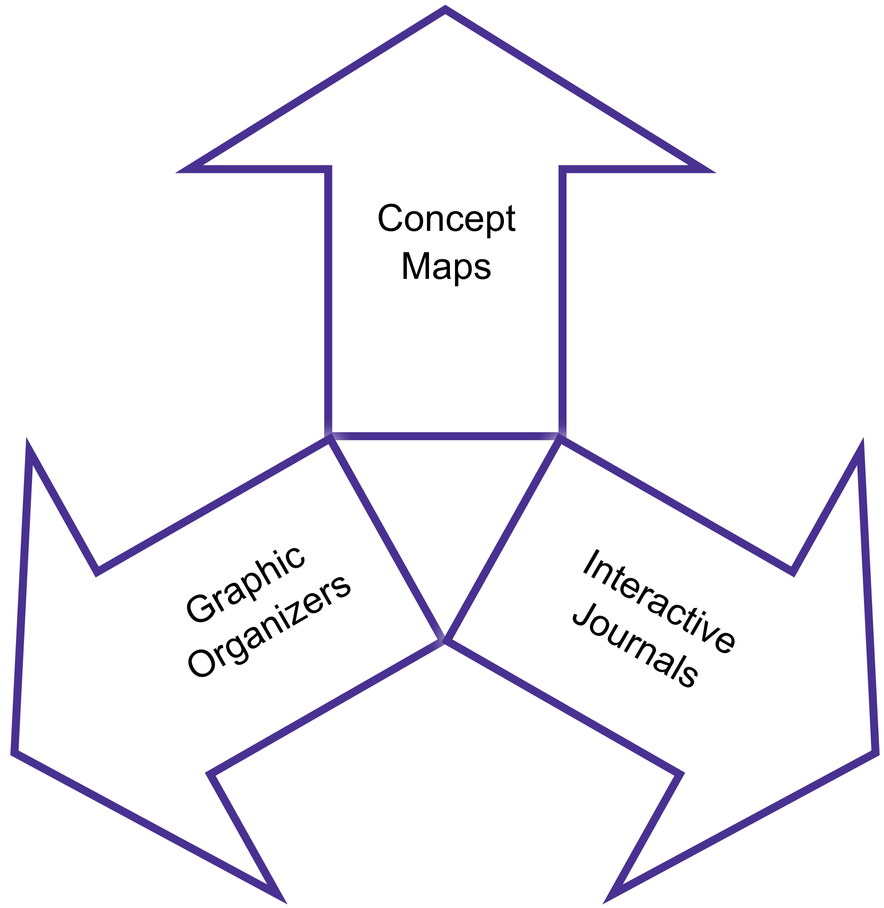


Figure 18

Post-Reading Stage: Concept Maps

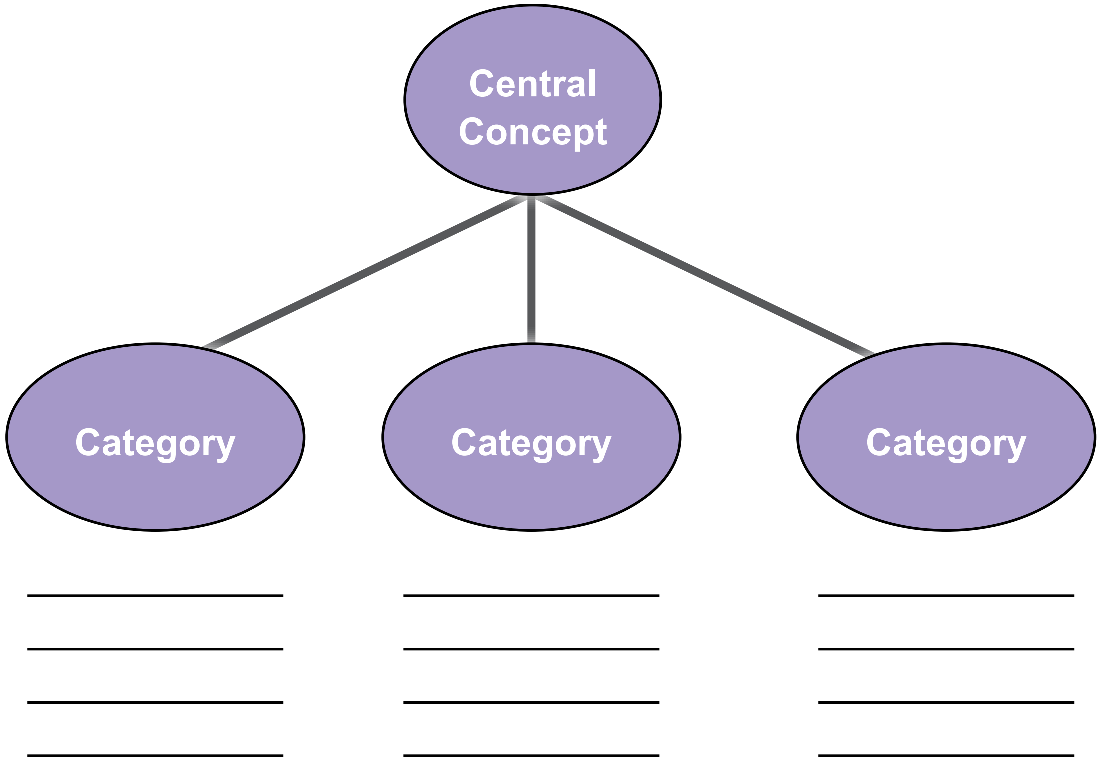
In the post-reading phase, concept maps are graphic organizers that provide students a method of graphically displaying attributes, qualities, or characteristics of a topic or concept.

Importance of Concept Maps

Concept maps help students demonstrate their understanding and elaborate through citing examples. Through learning and applying the strategy, students see how ideas are connected and that information can be grouped and organized. Any linking to prior knowledge assists the student with understanding.

Concept Map

To teach the strategy, the teacher would provide a template of the concept map and model how to use the map. The student would then be required to complete a concept map after their reading or unit study. The student identifies the central concept and underlying topics, then provides specific detail about the topics. Once the map is completed, the students are then to write a summary of the map contents. The below concept map is a simple map that could be expanded to a more complex form.



Content Objective: Exponentials

The student is being tested over the knowledge of the exponentials laws.

What exponent rules would I use to solve this problem?

$$\frac{(-2x^3y)^2\,(-xy^4)^3}{(3x^2y^5)^4}$$

Exponent Rules

Power Rule
Power to Power,
multiply exponents
$(-xy^3)^5 = (\,(-x)^5y^{15})$

Product Rule
Same base,
add exponents
$x^3\,x^5 = x^{3+5} = x^8$

Quotient Rule
Power to Power
Same base, subtract exponents

$$\frac{x^7y^2}{x^3y^5} = x^{7-3}\,y^{2-5} = x^4y^{-3} = \frac{x^4}{y^3}$$

Science Example: Concept Map

Content Objective: Body Systems

After the student reads, teach them to use a concept map to summarize what they have read.

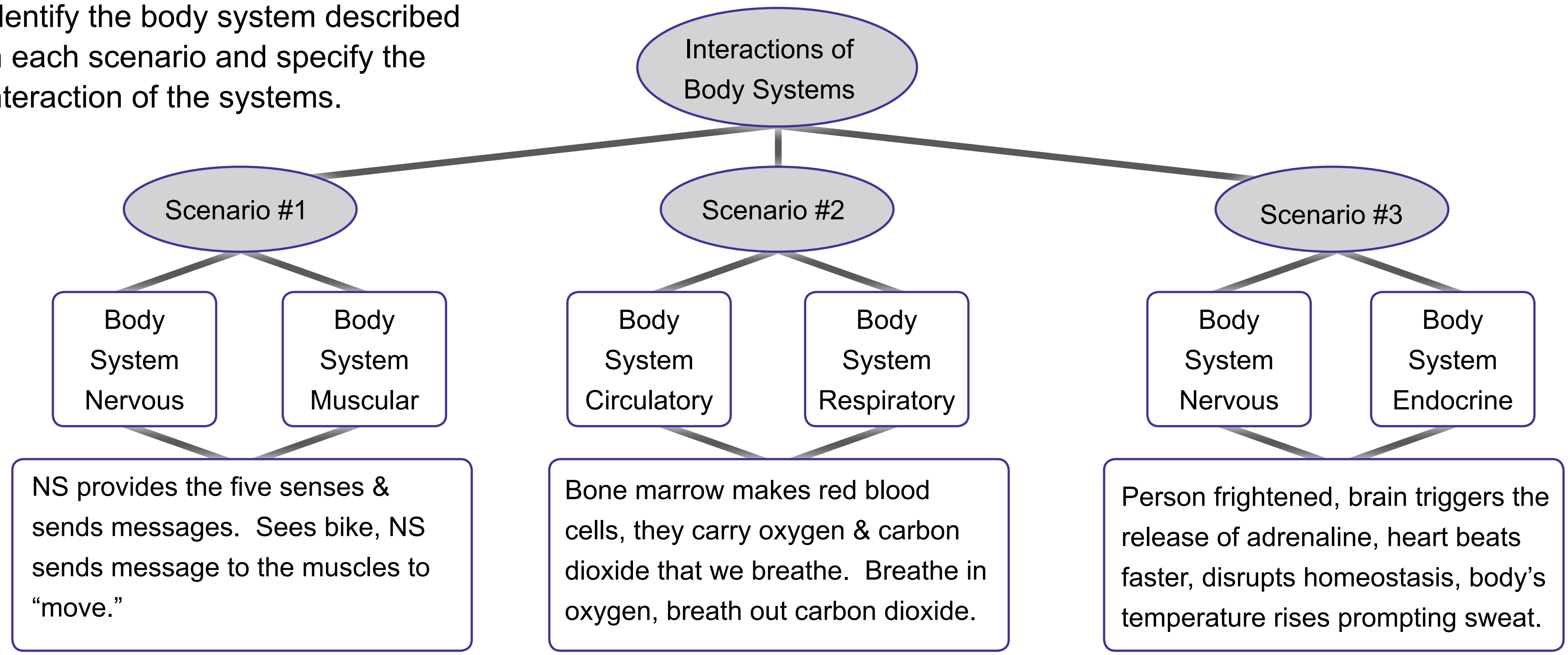
Example

Scenario #1: When a bicyclist sees a car in their path, the natural reaction is to immediately move out of the way to prevent serious injury.

Scenario #2: Bone marrow makes the cells that are necessary to carry oxygen and carbon dioxide.

Scenario #3: The hormone adrenaline causes excessive sweating in a person who has been frightened.

Identify the body system described in each scenario and specify the interaction of the systems.



(Nacogdoches and Lufkin HS Biology Teachers)

Post-Reading Stage: Interactive Journals/Notebooks

Interactive journals/notebooks can be an effective post-reading strategy that students can learn in high school and utilize for the rest of their lives. It is a form of writing in which students make thoughtful connections to texts, activities, and experiences. It forces them to process information on a daily basis. The note taking section in the during-reading stage can also be utilized as a post-reading strategy.

Importance of Interactive Journals/Notebooks
An interactive journal provides an opportunity for the student to reflect and process new learning. It elicits the student's processing of the information rather than a restatement of presented information. Through processing, the student's information moves from short-term memory to long-term memory. It provides a variety of ways for students to demonstrate their understanding of what they have read or heard.

Interactive Journals

The right side is used for note taking or conducting experiments. Students use the left side of the page to interact with the information in their own unique way.

One example from our science teachers
The small aquarium that you built and populated will provide many opportunities to identify examples of interactions between organisms and the environment. As we study these relationships, take notes on the right side of the page. On the left side of the page, illustrate or describe examples that you observe or infer from your observations of your aquarium.

Learn more about interactive notebooks and how to organize one.

See example of a foldable interactive notebook.

See an example of an interactive notebook.

Post-Reading Stage: Graphic Organizers

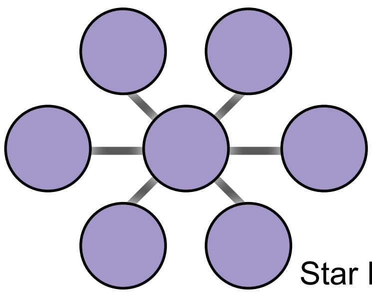
In the post-reading stage, graphic organizers provide a visual representation for the student of the concepts that have been taught. They allow the student to:

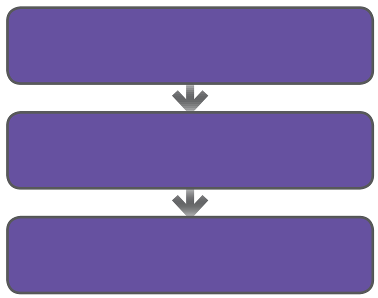
- visually sort new information into familiar categories
- analyze the relationships between old and new information
- create a simple structure for thinking about information in new ways
- review concepts and demonstrate understanding.

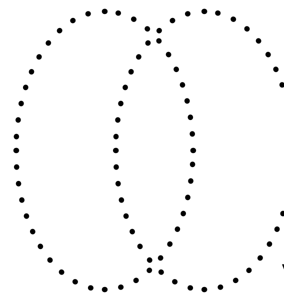
They are excellent study tools and allow the student to see relationships. These graphic organizers can be used after taking notes to summarize materials.

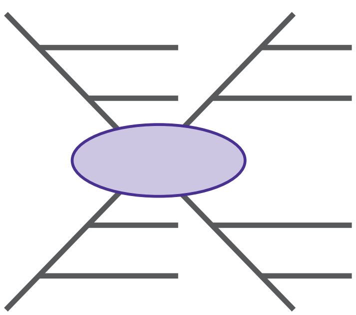
For science and math, graphic organizers can be beneficial during the note taking stage as well. They help students process abstract ideas and to visualize the core concepts.

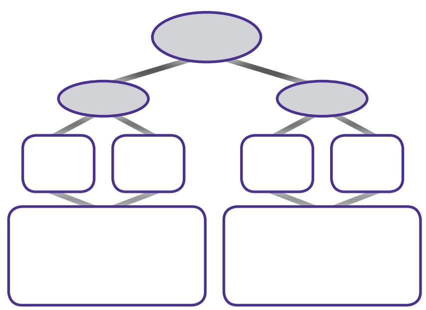
See an example of a graphic organizer used by a student to take notes.

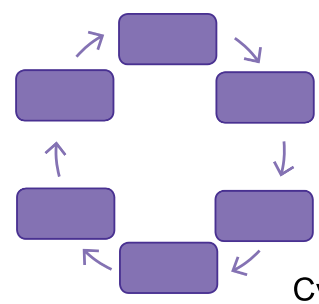

Star Diagram


Chain Diagram


Venn Diagram


Spider Diagram


Tree Diagram


Cycle Diagram

Mathematics Example: Graphic Organizers

Content Objective: Inverse of a Function

Finding the Inverse of a Function
The below is taken from a student's notes. The student will review the notes and utilize a graphic organizer to represent his/her thinking.

$y = 3x - 2$	**Original function**
$y + 2 = 3x$	Solve for x
$\frac{y + 2}{3} = x$	
$\frac{y = x + 2}{3}$	When I solve for "x," switch x and y
$y = \frac{(x + 2)}{3}$	"y" is the inverse

Graphic organizer designed by student in his notes:
How do I find the inverse of a function?

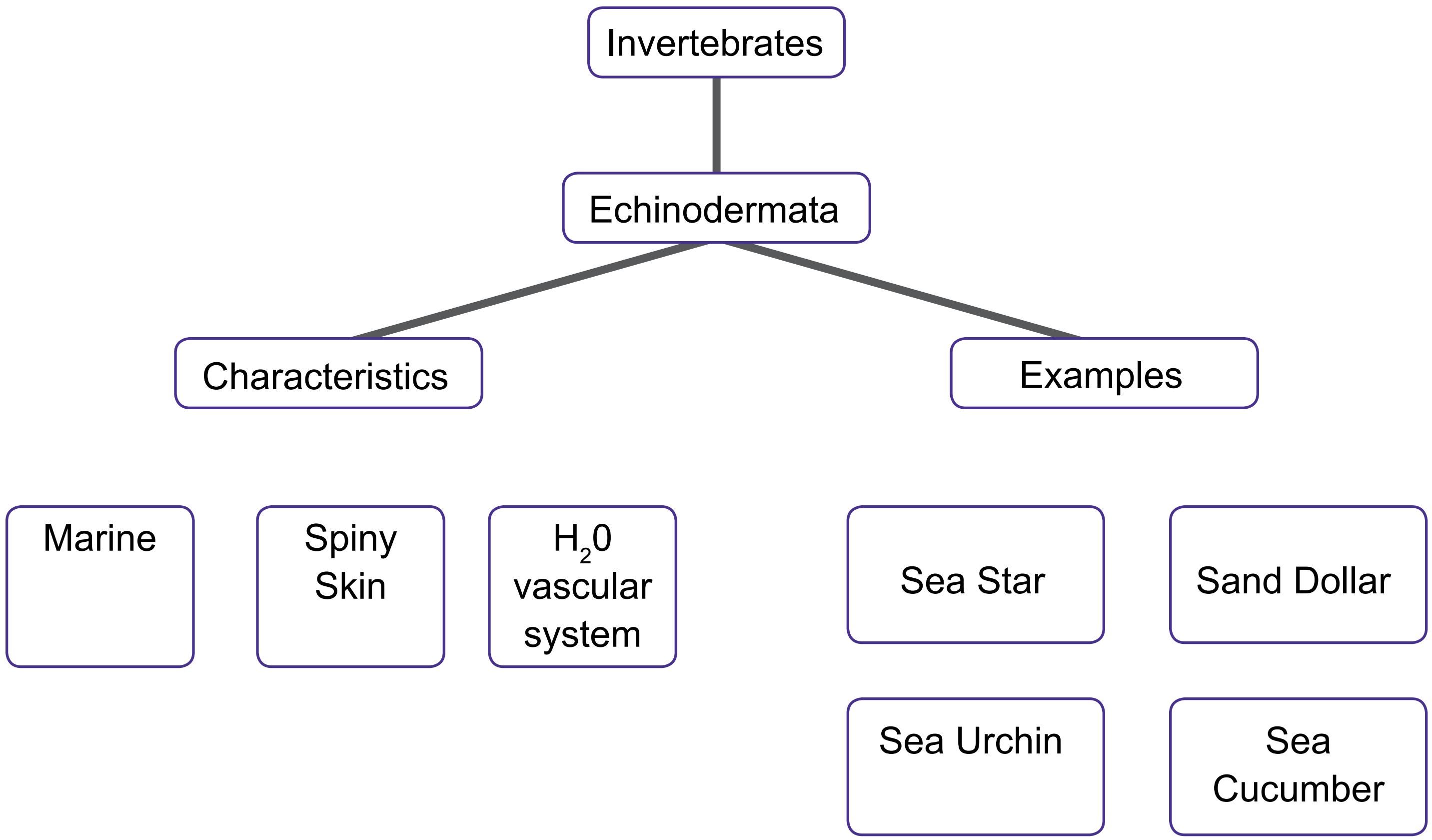
Original Function →	$y = x^2$
Solve for x →	$\sqrt{y} = \sqrt{x^2}$
Switch x and y →	$\sqrt{x} = \sqrt{y^2}$
Rewrite as $f^{-1}(x)$ →	$f^{-1}(x) = \sqrt{x}$

Science Example: Graphic Organizers

Content Objective: Classification

Invertebrates in the Phylum Echinodermata are marine animals with radial symmetry. In this symmetry, the organs of the echinoderm are located in the repetitious rays around a central disk. Sea stars, sea cucumbers, sand dollars, and sea urchins are examples.

Echinoderms, meaning spiny skin, have a water vascular system for respiration, hydraulic propulsion, and for obtaining food.



Final Thoughts on Post-Reading Stage

The post-reading stage or reflective stage help students transform new information from the during-reading stage into their own words, personalizing the information and integrating it into their prior knowledge.

In this stage, strategies that are being taught should teach students how to “own” the information that has been taught, extending ideas and connecting texts, and putting information into schema and long-term memory.

Closing Remarks

The STEPS team commends you as you have voluntarily pursued this module as one resource to enhance your understanding of the importance of developing independent readers in your mathematics and science classrooms.

Our STEPS team fully acknowledges that there are any number of reading strategies, with this module only introducing a few. We encourage you to begin thinking about modeling theses strategies and researching others, so that when your students leave your supervision, they will be equipped to independently utilize the strategies to assist with their overall comprehension.

The STEPS team acknowledges your dedication to our Texas students and confidently joins you as we prepare our students to enter a globally competitive, highly interactive job market upon graduation.

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Beth Gound graduated from Stephen F. Austin State University in 1992. She then obtained her Masters of Reading and Literacy from the University of North Texas in 2002. She taught reading in the public school for 14 years. For the past five years she has served as a visiting professor in the secondary education department at Stephen F. Austin State University.

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Dr. Sarah T. Stovall is an Associate Professor of Mathematics at Stephen F. Austin University. She has taught a variety of courses, including many in the sequences for pre-service elementary, middle, and secondary school teachers, and has participated at various levels in numerous grant activities designed for in-service teachers. Since 2008, she has co-authored two online mathematics courses that have made it possible for over 160 rural high school students to receive dual credit in college algebra and college trigonometry.

The findings related and views expressed in this report are solely those of the authors and do not necessarily represent the views of, and should not be attributed to, the Texas Higher Education Coordinating Board.

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Supporting Information

Mathematics Standards

Return

III. Geometric Reasoning

C. Connections between geometry and other mathematical content strands

1. Make connections between geometry and algebra.

a. Describe lines in the coordinate plane using slope-intercept and point-slope form.
b. Use slopes to describe the steepness and direction of lines in the coordinate plane and to determine if lines are parallel, perpendicular, or neither.
c. Relate geometric and algebraic representations of lines, segments, simple curves, and conic sections [e.g., describe algebraically a circle centered at (h, k) with radius (r)].
d. Investigate and justify properties of triangles and quadrilaterals using coordinate geometry.
e. Relate the number of solutions to a system of equations of lines to the number of intersections of two or more graphs.

2. Make connections between geometry, statistics, and probability.

a. Compute probabilities using lengths of segments or areas of regions representing desired outcomes.
b. Construct a trend line or a regression line for a scatter plot and use it to make predictions.

3. Make connections between geometry and measurement.

a. Determine perimeter and area of two dimensional figures and surface area and volume of three-dimensional figures using measurements and derived formulas.
b. Find the measures of the lengths and areas of similar figures and of the lengths, surface areas, and volumes of similar solids.
c. Find arc length and sector area for a given central angle on a circle.

(EPIC, 2008, p. a14)

Mathematics Standards

Return

X. Connections	
A. Connections among strands of mathematics	B. Connections of mathematics to nature, real-world situations, and everyday life
1. Connect and use multiple strands of mathematics in situations and problems. a. Represent a geometric two-dimensional figure on the rectangular coordinate plane using a set of equations or inequalities. b. Connect the concepts of ratios, rates, proportions, and percents (e.g., show slope as constant rate of change using similar triangles). c. Compare and contrast different mathematical concepts and procedures that could be used to complete a particular task. d. Combine appropriate numeric, algebraic, geometric, and statistical/probabilistic methods to solve a given problem. **2. Connect mathematics to the study of other disciplines.** a. Use mathematical models to solve problems in areas such as science, business, and economics. b. Use applications of mathematics (e.g., carbon dating, exponential population growth, amortization tables). c. Use geometric concepts and properties to solve problems in fields such as art and architecture. *(EPIC, 2008, p. a22)*	**1. Use multiple representations to demonstrate links between mathematical and real-world situations.** a. Model a given real-world situation using an appropriate combination of sketches, graphs, and algebraic expressions. b. Describe a given real-world situation in algebraic terms, and then use that description to produce a geometric description, and vice-versa. c. Connect mathematically created tables, graphs, and functions to fit real-life situations (e.g., download data from the Internet). *(EPIC, 2008, p. a22)*

Science Standards

Return

II. Foundation Skills: Scientific Application of Mathematics		
A. Basic mathematics conventions	B. Mathematics as a symbolic language	C. Understand relationships among geometry, algebra, and trigonometry
1. Understand the real number system and its properties. 2. Use exponents and scientific notation. 3. Understand ratios, proportions, percentages, and decimal fractions, and translate from any form to any other. 4. Use proportional reasoning to solve problems. 5. Simplify algebraic expressions.	1. Carry out formal operations using standard algebraic symbols and formulae. 2. Represent natural events, processes, and relationships with algebraic expressions and algorithms.	1. Understand simple vectors, vector notations, and vector diagrams, and carry out simple calculations involving vectors. 2. Understand that a curve drawn on a defined set of axes is fully equivalent to a set of algebraic equations. 3. Understand basic trigonometric principles, including definitions of terms such as sine, cosine, tangent, cotangent, and their relationship to triangles. 4. Understand basic geometric principles. *(EPIC, 2008, p. a25-a27)*

V. Cross -Disciplinary Themes				
A. Matter/states of matter	B. Energy (thermodynamics, kinetic, potential, energy transfers)	C. Change over time/equilibrium	D. Classification	E. Measurements and models
1. Know modern theories of atomic structure. 2. Understand the typical states of matter (solid, liquid, gas) and phase changes among these.	1. Understand the Laws of Thermodynamics. 2. Know the processes of energy transfer.	1. Recognize patterns of change.	1. Understand that scientists categorize things according to similarities and differences.	1. Use models to make predictions. 2. Use scale to relate models and structures. 3. Demonstrate familiarity with length scales from sub-atomic particles through macroscopic objects. *(EPIC, 2008, p. a30-a31)*

Cross-Disciplinary Standards/ Science Standards

Return

II. Foundational Skills	III. Foundational Skills
A. Reading across the curriculum	B. Scientific Reading
1. Use effective pre-reading strategies. a. Use the title, knowledge of the author, and place of publication to make predictions about a text. b. Use a table of contents to preview a text and understand its design. c. Scan headline sections or other division markers, graphics, or sidebars to form an overview of a text. **2. Use a variety of strategies to understand the meanings of new words.** a. Use context clues, including definitions, examples, comparison, contrast, cause and effect, and details provided in surrounding text. b. Consult references (e.g., dictionary, thesaurus) effectively. c. Understand notation specific to discipline (e.g., mathematical notation, scientific symbols). *(EPIC, 2008, p. a61)*	**4. List, use and give examples of specific strategies before, during, and after reading to improve comprehension.** a. List strategies to use before reading, including: activate prior knowledge of the topic, gain a clear understanding of the goal or purpose of the reading, and analyze the way in which the material is structured. 2. Recognize scientific vocabulary in the filed of study and use this vocabulary to enhance clarity of communication *(EPIC, 2008, p. a28)*

Cross-Disciplinary Standards/ Science Standards

Return

II. Foundational Skills	III. Foundational Skills
A. Reading across the curriculum	B. Scientific Reading
7. Adapt reading strategies according to structure of texts. a. Identify a variety of textual forms and genres (e.g., long and short texts) and adapt reading strategies accordingly. b. List strategies to use during reading, • including: • Anticipate and predict what information the text is likely to contain. • Monitor understanding by self questioning. • Use strategies (e.g., mental imagery, paraphrasing, information in glossaries) to reexamine the text if comprehension fails. • Reread difficult passages. • Read ahead for additional clarification • Seek assistance for clarification. • Self-monitor and summarize the information gained. *(EPIC, 2008, p. a77)*	**4. List, use, and give examples of specific strategies before, during, and after reading to improve comprehension.** b. List strategies to use during reading, including: focus attention on the text; anticipate and predict what information the text is likely to contain; monitor understanding by self-questioning and the use of strategies (e.g., mental imagery, paraphrasing, information in glossaries) to re-examine the text if comprehension fails; reread difficult passages or read ahead for additional clarification; seek outside help for clarification; frequently self-monitor and summarize the information that has been gained. *(EPIC, 2008, p. a38)*

Cross-Disciplinary Standards/ Science Standards

Return

II. Foundational Skills	III. Foundational Skills
A. Reading across the curriculum	B. Scientific Reading
4. Identify the key information and supporting details. a. Outline a chapter of an informational text. b. Summarize the major points in a text and use graphic organizers (e.g., concept maps, diagrams) to organize ideas and concepts in a visual manner. c. Analyze connections between major and minor ideas. d. Identify and define key terminology from technical and/ or scientific documents. **5. Analyze textual information critically.** a. Identify faulty premises in an argument. b. Identify stated and implied assumptions. c. Identify conclusions unsupported by sufficient evidence in informational texts. d. Use inductive and deductive reasoning. e. Draw conclusions based on evidence, support, or data through logical reasoning. f. Compare a primary source and an interpretation in a textbook. *(EPIC, 2008, p. a77)*	**4. List, use, and give examples of specific strategies before, during, and after reading to improve comprehension.** c. List strategies to use after reading, including: summarize the major points in the text and use graphic organizers (e.g., concept maps, problem-solution diagrams, cycle diagrams) to organize terms and concepts from the text in a visual manner. *(EPIC, 2008, p. a38)*

Cross-Disciplinary Standards

Return

II. Foundational Skills
A. Reading across the curriculum
1. Use effective pre-reading strategies a. Use the title, knowledge of the author, and place of publication to make predictions about a text. b. Use a table of contents to preview a text and understand its design. c. Scan headline sections or other division markers, graphics, or sidebars to form an overview of a text. **2. Use a variety of strategies to understand the meanings of new words.** a. Use context clues, including definitions, examples, comparison, contrast, cause, and effect, and details provided in surrounding text. b. Consult references (e.g., dictionary, thesaurus) effectively. c. Understand notation specific to discipline (e.g., mathematical notation, scientific symbols). *(EPIC, 2008, p. a61-62)*

Return

Examples

$y = x$

$y = 2x - 1$

$y = -\frac{2}{5}x$

$y = x^2$

$y = (x-2)^2 + 1$

$f(x) = -x^2 + x$

$y = -0.2(4x-3)(x+3)$

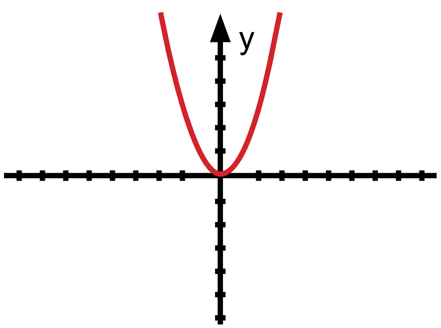
$y = x^3 + 2x^2 - x + 11$

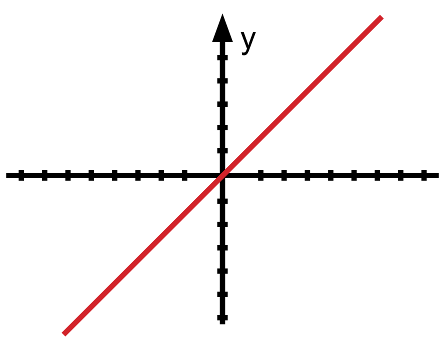
$y = 4$

$h(x) = -x^4 + \frac{1}{2}x^2 - 3$

$y = -4x^0 + 4$

$y = x(x^2 - 4)(x+2)$





Non-Examples

$y = \sqrt{x}$

$f(x) = 3x^{\frac{1}{2}} - x$

$x = -6$

$x^2 + y^2 = 16$

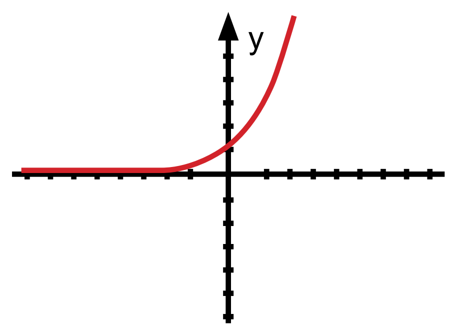
$h(x) = \sqrt[3]{x}$

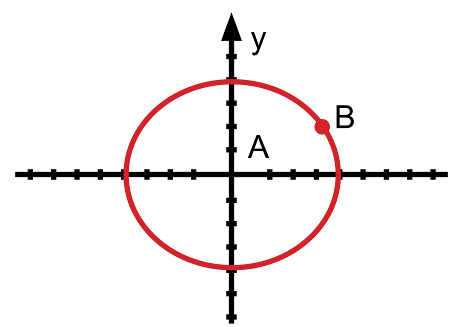
$y = \sin^{\beta}$

$y = \frac{1}{x-2}$

$y = 2^x$

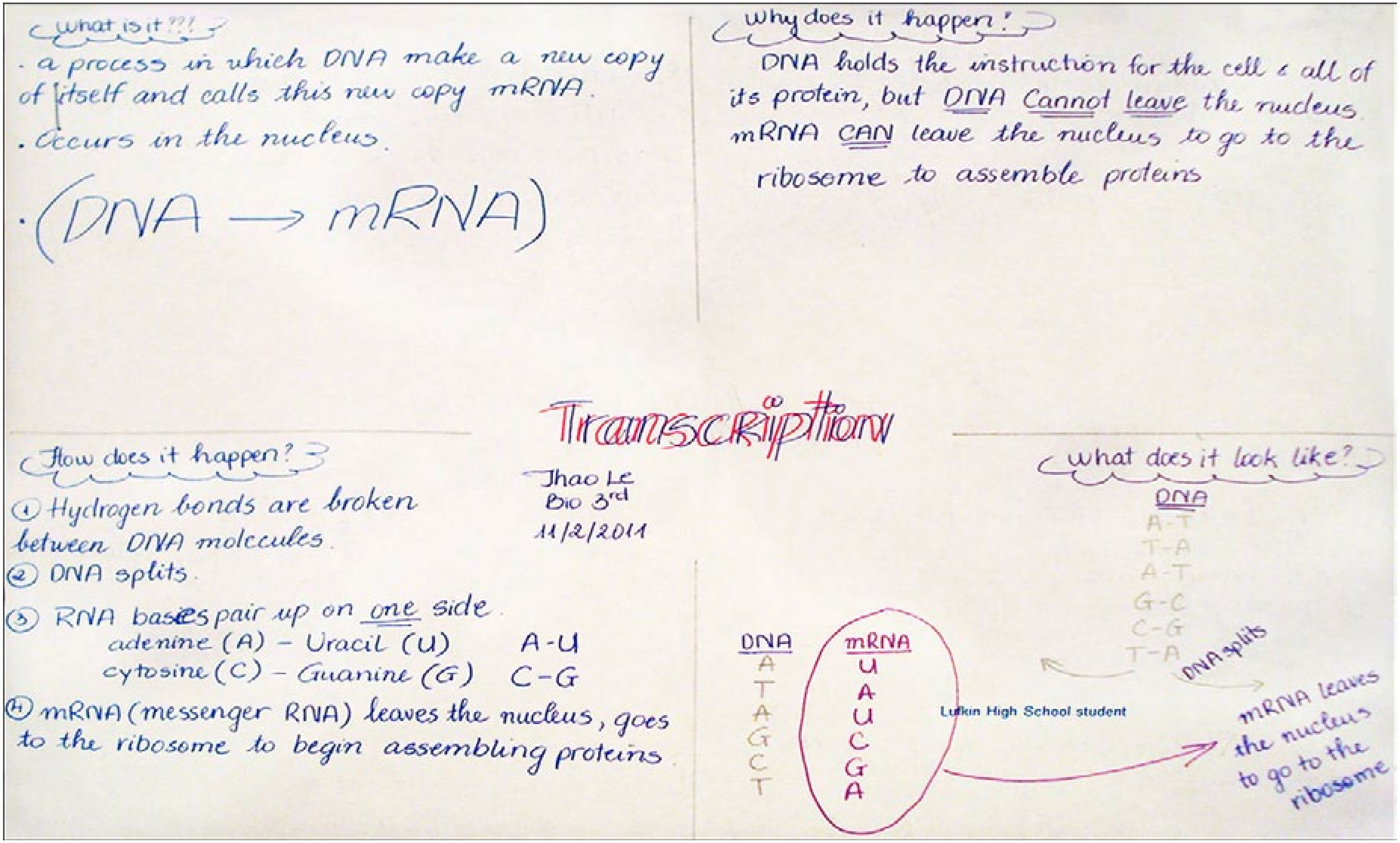
$y = \frac{x-1}{x^2 - x + 1}$





Example of Interactive Notebooks

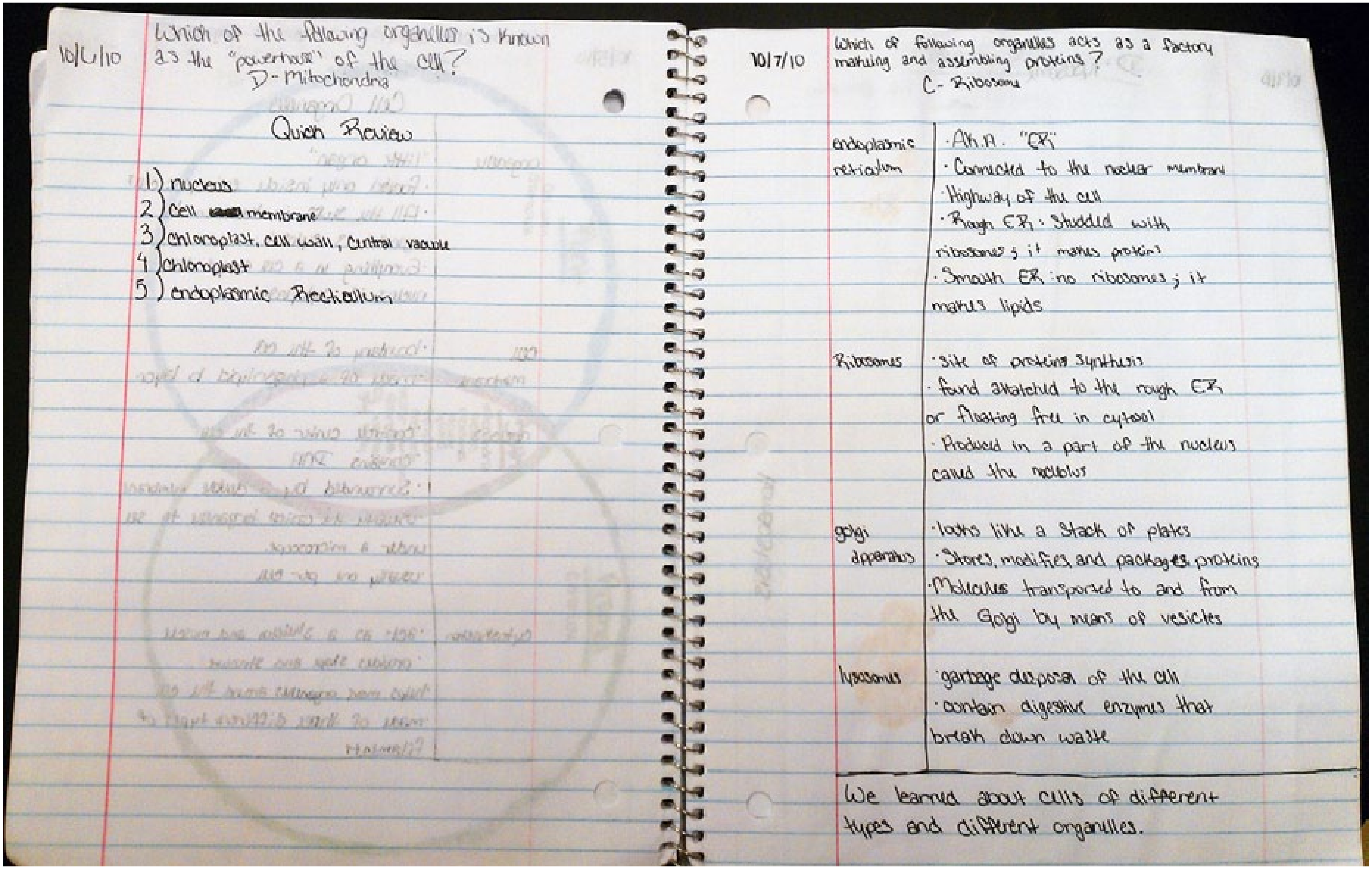
Return



(Lufkin High School student)

Example of Interactive Notebooks

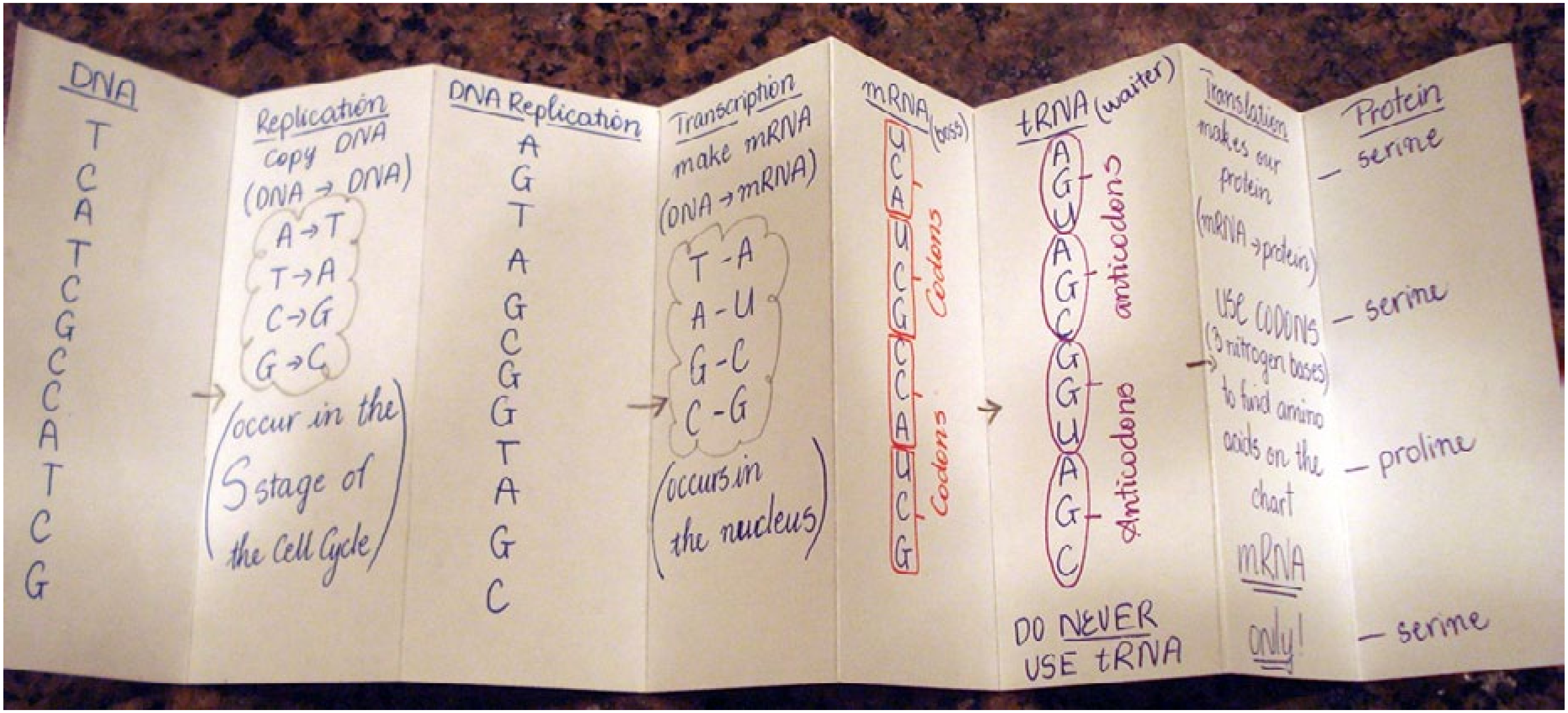
Return



(Woden High School student)

Example of Graphic Organizer

Return



(Lufkin High School student)

SCAVENGER HUNT – for PRENTICE HALL BIOLOGY – TEXAS STUDENT EDITION

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This exercise will help you know what is in your biology textbook and how it is organized. Answer the following questions by referring to the textbook:

On what page number does the **Table of Contents** start?	
What is the title of **Unit 6**?	
Look at the Unit Overview on pages 166-167. How many chapters are in **UNIT 3**?	
On what page number is **Appendix A** on Science Skills found?	
On what page number is **Appendix B** on Safety found?	
On what page number is **Appendix E** on Classification found?	
On what page does the **English Glossary** begin?	
On what page does the **Spanish Glossary** begin?	

The following questions will take you through the features in a typical unit and chapter. Answer the following questions about the unit and chapter features:

At the beginning of units, there will be a short message **From the Author**, as well as web codes for updated information. What is the web code for Unit 1?	
At the beginning of Chapter 1, section 1, on page 3, what information do you find by the Texas icon?	
There are two Key icons on page 3. What do you find next to the Key icons?	
Notice the Checkpoint question on page 5. Where can you find the answer to this question?	
On page 14, you are referred to links on experimenting. Which website will you visit to find these links?	
On page 17, why do you find Key icons in the captions to the visuals?	

(Hudson HS Biology Teacher)

Example of Cornell Note Taking Template

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Cue Column 2 ½” ⟵⟶	Note Taking Column 6” ⟵⟶
	1. **Record:** During the lecture, use the note taking column to record the lecture using telegraphic sentences. 2. **Questions:** As soon after class as possible, formulate questions based on the notes in the right-hand column. Writing questions helps to clarify meanings, reveal relationships, establish continuity, and strengthen memory. Also, the writing of questions sets up a perfect stage for exam-studying later. 3. **Recite:** Cover the note taking column with a sheet of paper. Then, looking at the questions or cue-words in the question and cue column only, say aloud, in your own words, the answers to the questions, facts, or ideas indicated by the cue-words. 4. **Reflect:** Reflect on the material by asking yourself questions, for example: “What’s the significance of these facts? What principle are they based on? How can I apply them? How do they fit in with what I already know? What’s beyond them?” 5. **Review:** Spend at least 10 minutes every week reviewing all your previous notes. If you do, you’ll retain a great deal for current use, as well as for the exam.
Summary After class, use this space at the bottom of each page to summarize the notes on that page.	

(Cornell Notes, n.d.)