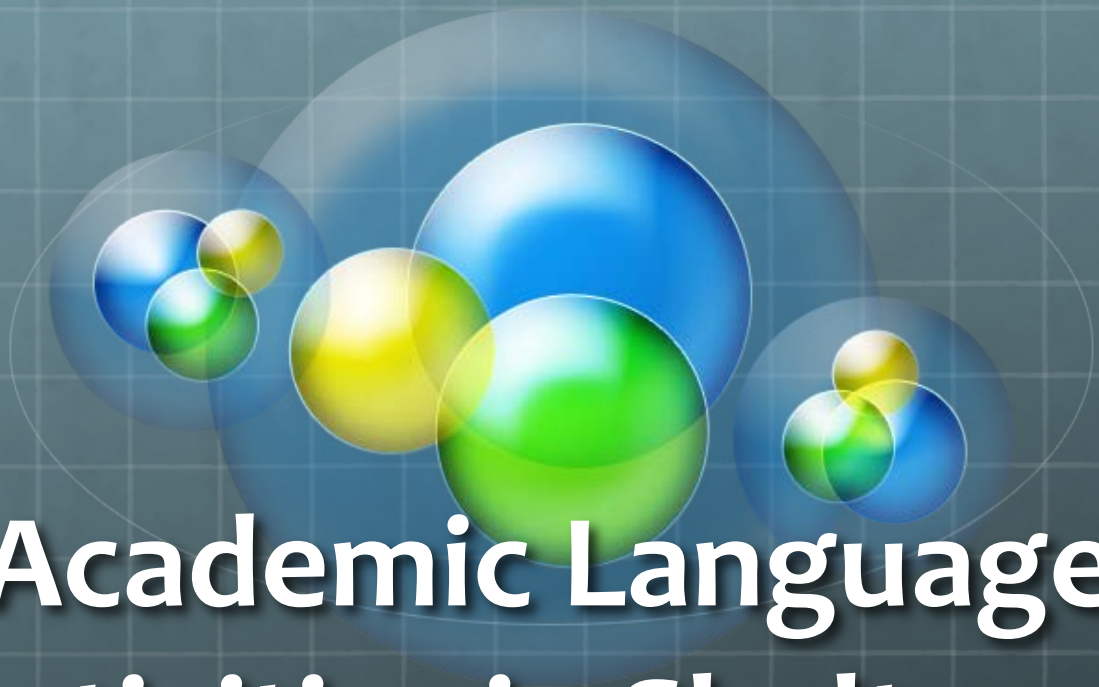

Academic Language Activities in Sheltered STEM Content Instruction

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English Learners in Secondary STEM Subjects

- ELs in Secondary Schools: Characteristics and Challenges
  1) Teenagers who immigrate to the U.S. have more difficulty than young learners -> Low high school graduation rates.
  2) When compared to those from English-speaking homes, the drop out rate is three times higher for this population.
  3) Academic content and vocabulary required for secondary subjects are much more challenging than elementary-level (25000- 30000 words should be learned by 9th grade).

Characteristics of Academic Language Required in STEM Content Subjects

- Vocabulary : Academic vocabulary vs Content-specific vocabulary. Latin-based root, prefixes, and suffixes
- Linguistic Structures: Passive voice, conditional clauses, complex and embedded clauses
- Text characteristics: Interpretive, Descriptive, Analytical, Argumentative, Supporting with evidence

STEM Sheltered Content Lesson Planning: Key Elements

- Lesson goals and objectives
- Content objectives and national standards (CCSS, NGSS)
- Language objectives and ELP standards (ELPA21)
- Content assessment and language assessment
- The extent of content and language integration (i.e., To what extent language-focused activities will/should be integrated into the content instruction, and what are the essential language aspects to be included in the lesson?)

Language and Literacy Integration into STEM Content Lessons: Key Considerations

- Identification of key content **vocabulary**
- Identification of key **linguistic structures**
- Identification of key **language functions**
- Consideration of ***different language proficiency levels*** of ELs in one classroom
- Balancing language skills (oral-language vs. written language; receptive language (listening or reading) vs. productive language skills (speaking or writing)

Identification of Key Content Vocabulary

- What is "key content vocabulary" and how do you identify them?
- How many new words in one lesson?
- Approaches to teaching key content vocabulary

  - Attention, Noticing, and *Input Enhancement* in Second language vocabulary learning (target vocabulary highlighted and enhanced to draw learners' attention)

  - *Morpheme*-based vocabulary learning (common morphemes used in content subjects focused and practiced in content lessons)

  - *Tiered* vocabulary learning (Tier 1 (basic) , Tier 2 (function words critical to learning Tier 3 words, Tier 3(content-specific low frequency words)

  - *Link-based* vocabulary learning based on thematic links (New words grouped based on thematic categories)

Identification of key linguistic structures

- What is “key linguistic structures” and how to identify them
- Linguistic scaffolding in STEM content instruction

  - Sentence starters (to prompt ELs to start with a correct sentence structures)

  - Leveled sentence frames (to accommodate different English proficiency levels)

Identification of key language functions

- Analysis of content teaching and learning materials for "key language function" identification
- Types of language functions: Descriptive, Interpretive, Comparative, Contrastive, Summative, Argumentative.
- Linguistic structures correlating with language functions

(e.g.,

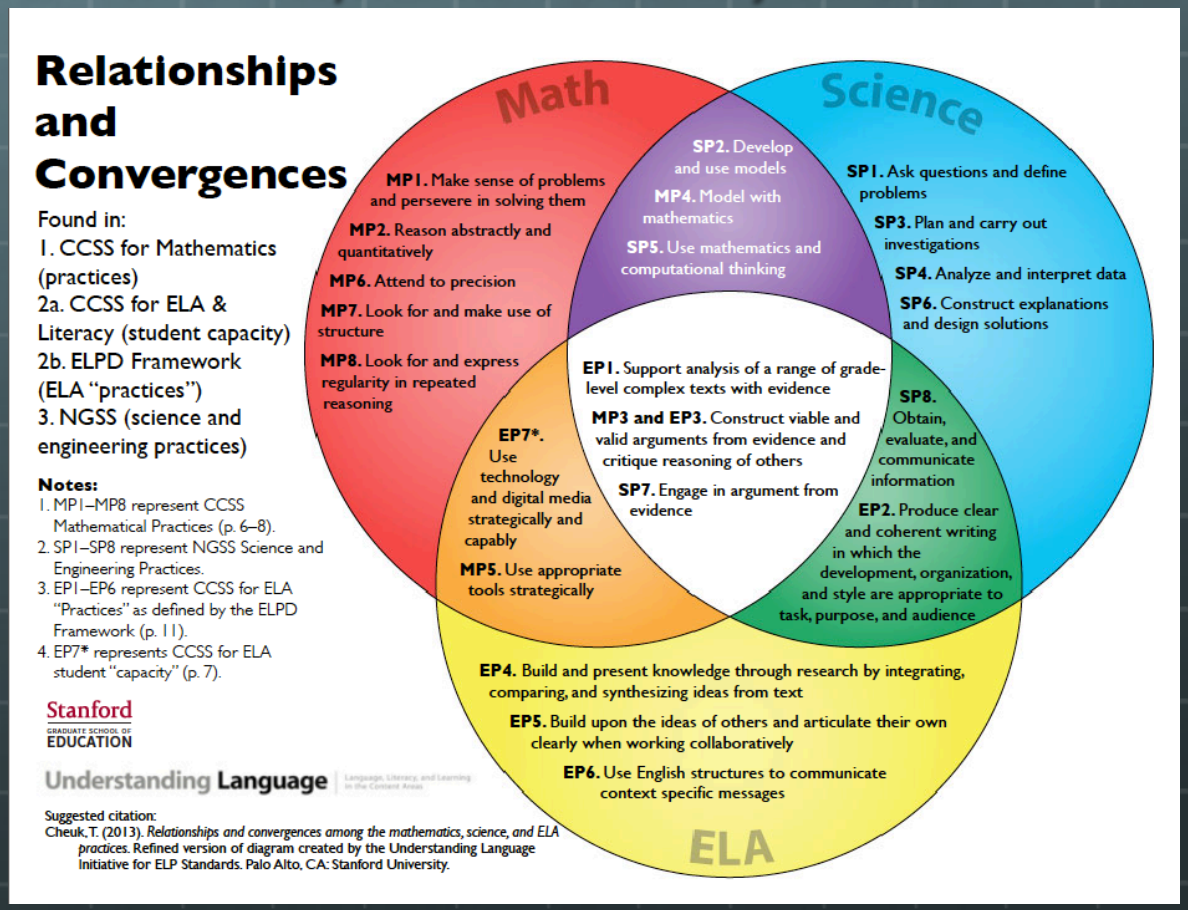
Descriptive/Defining: A is B. Interpretive: A is inferred from B.

Comparative: A is _____er/more ____ than B. Summative: In summary, A is B.

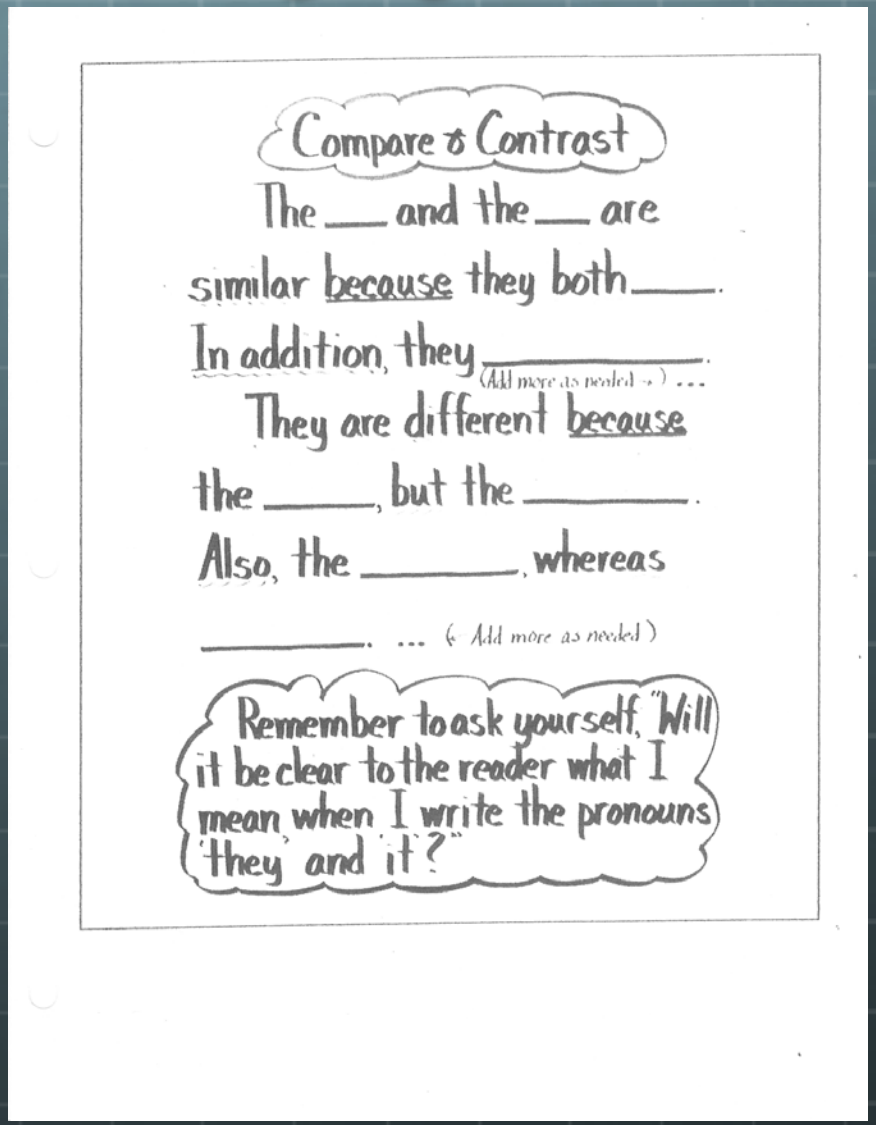
Argumentative: A is B because B is C.)

Academic Language Integration for Alignment with NGSS and CCSS

- How language and literacy integration is essential for the alignment with NGSS and CCSS
- Example NGSS and CCSS standards showing how language and literacy competency is emphasized in all content subject areas for secondary learners.



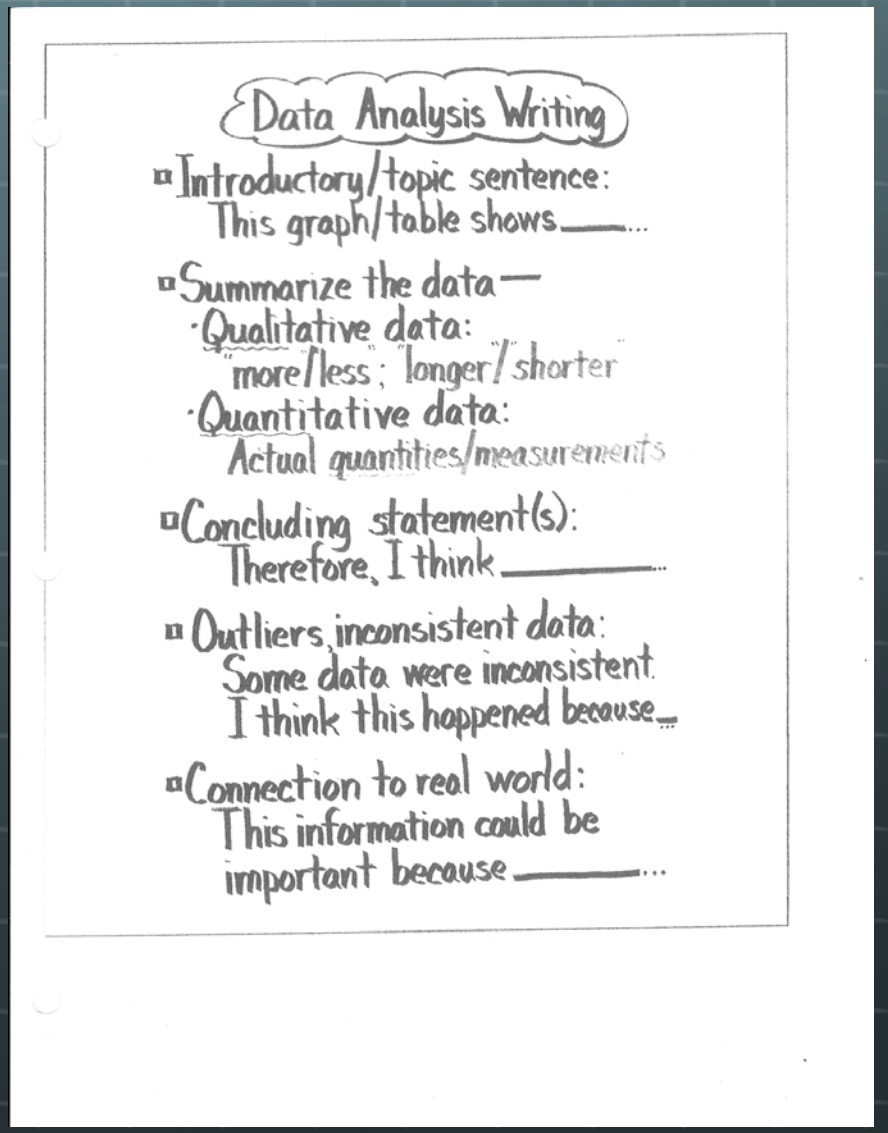
Teacher's Experiences with Integrating Language Instruction with STEM Content



Compare & Contrast

The ___ and the ___ are similar because they both ___.
In addition, they ___. (Add more as needed →) ...
They are different because the ___, but the ___.
Also, the ___, whereas ___. ... (← Add more as needed)

Remember to ask yourself, "Will it be clear to the reader what I mean when I write the pronouns 'they' and 'it'?"



Data Analysis Writing

- Introductory/topic sentence:
  This graph/table shows ___...
- Summarize the data—
  - Qualitative data:
    "more/less"; "longer"/"shorter"
  - Quantitative data:
    Actual quantities/measurements
- Concluding statement(s):
  Therefore, I think ___...
- Outliers, inconsistent data:
  Some data were inconsistent.
  I think this happened because ___
- Connection to real world:
  This information could be important because ___...

Traditional Science Class Question and Answer

12/07/09

How does a neon bulb Compare with an incadescent bulb?

They do not look alike.
The Incodescent and neon probably dont work the same way because the insides are different. we can turn them on to find out by observing when they are on.

NEON BULB

electricity jumps back & forth

Incodescent BULB

The electricity travels thrue the wire.

Data Table

What patterns can be seen in the mass, volume, and density of various substances?

Background information:

We know that mass measures the amount of matter in a sample, volume is the amount of space a sample takes up, and density is the relationship between the mass and the volume.

Procedure:

For each substance, we will find the mass, volume and density for one or more samples.

Data Table

Substance	Mass	Volume of water only	Volume of water + sample	Volume of sample (subtract V of water)	Density (M divided by V)
Steel S	33.1	40	45	5	6.62
steel M	59.5	40	48	8	7.4375
steel L	70.3	40	49	9	7.8111111
Brass S	7.3	40	47	2	3.65
brass M	16.7	40	44	4	4.175
Brass L	39	216	216	6	6.5
Plastic S	6.5	40	48	8	0.8125
Plastic M	8.5	210	222	12	0.70833333
Plasti L	11.5	230	244	14	0.82142857

Data Analysis for question, **What patterns can be seen in the mass, volume, and density of various substances?**

See any patterns yet? Describe what you see.

Scaffolded Data Analysis

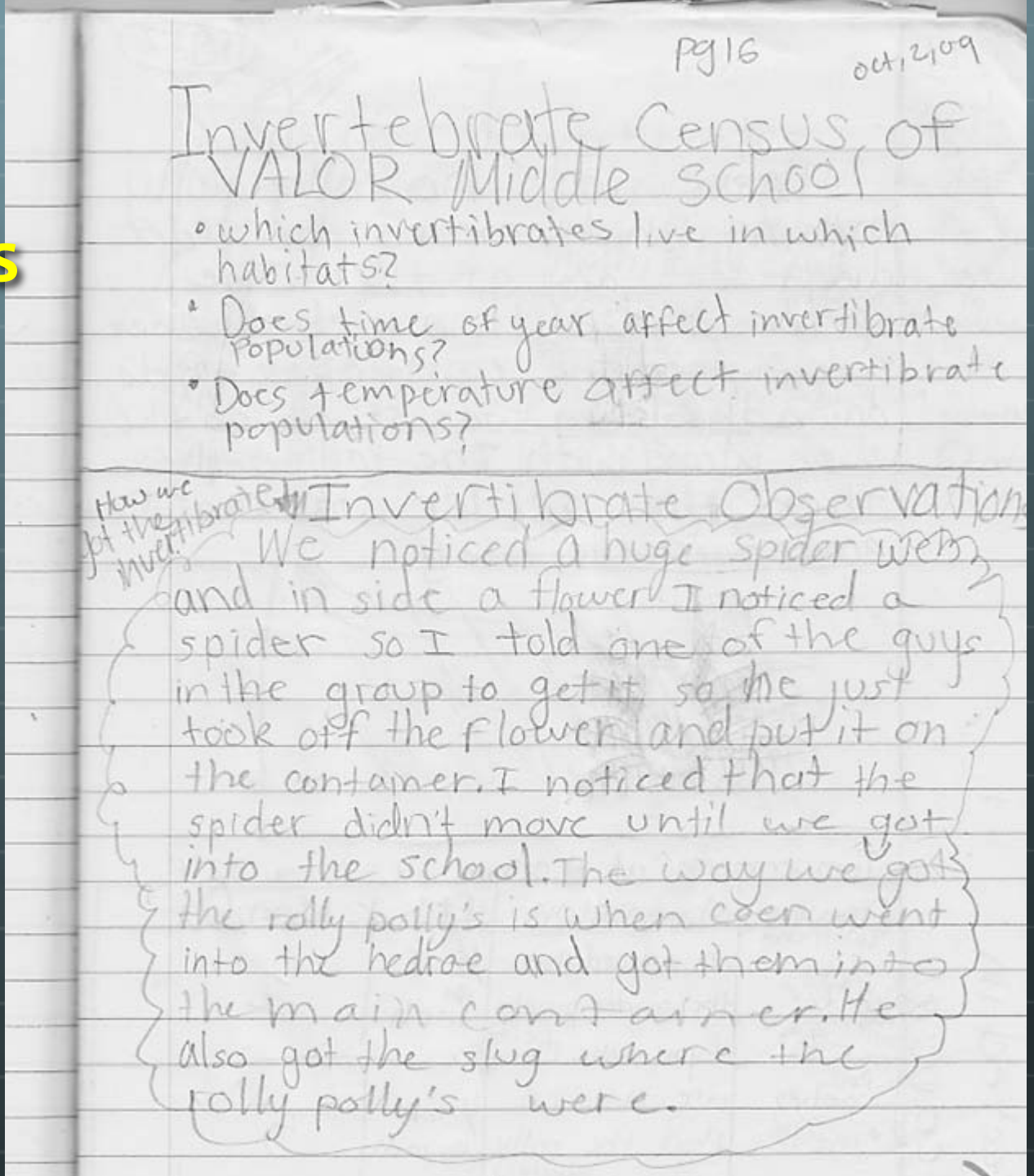
Observations:

The densities for each material (substance) are about the same. The masses of the substance were different, the volume were different to.

Data Analysis

This table shows the mass, density and volume of various substances. The densities are more similar than the volumes. They are also more similar than the masses. The bass wood densities 0.49, 0.45, and 0.45 PVC densities were 1.45, 1.32, and 1.66. The densities of plastic were 0.81, 0.70, and 0.81. By the contrast the volume of bass wood was 28 milliliters, 46 ml, and 60 ml. There for we think that the densities are always the same. Even though the mass and volume can be different.

Scaffolded Observations



pg 16 oct, 2, 09

Invertebrate Census of VALOR Middle School

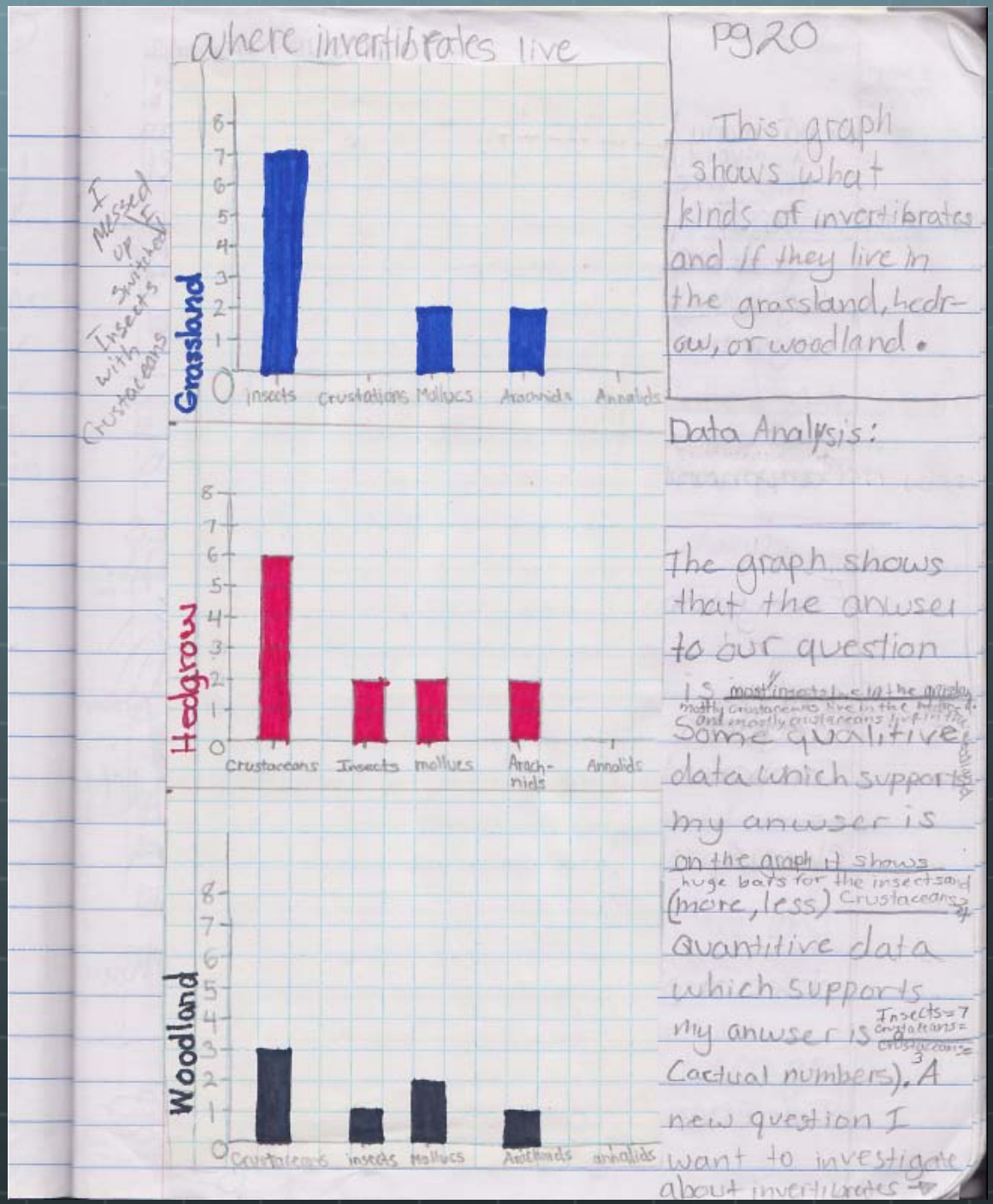
- which invertibrates live in which habitats?
- Does time of year affect invertibrate populations?
- Does temperature affect invertibrate populations?

How we got the invertibrates

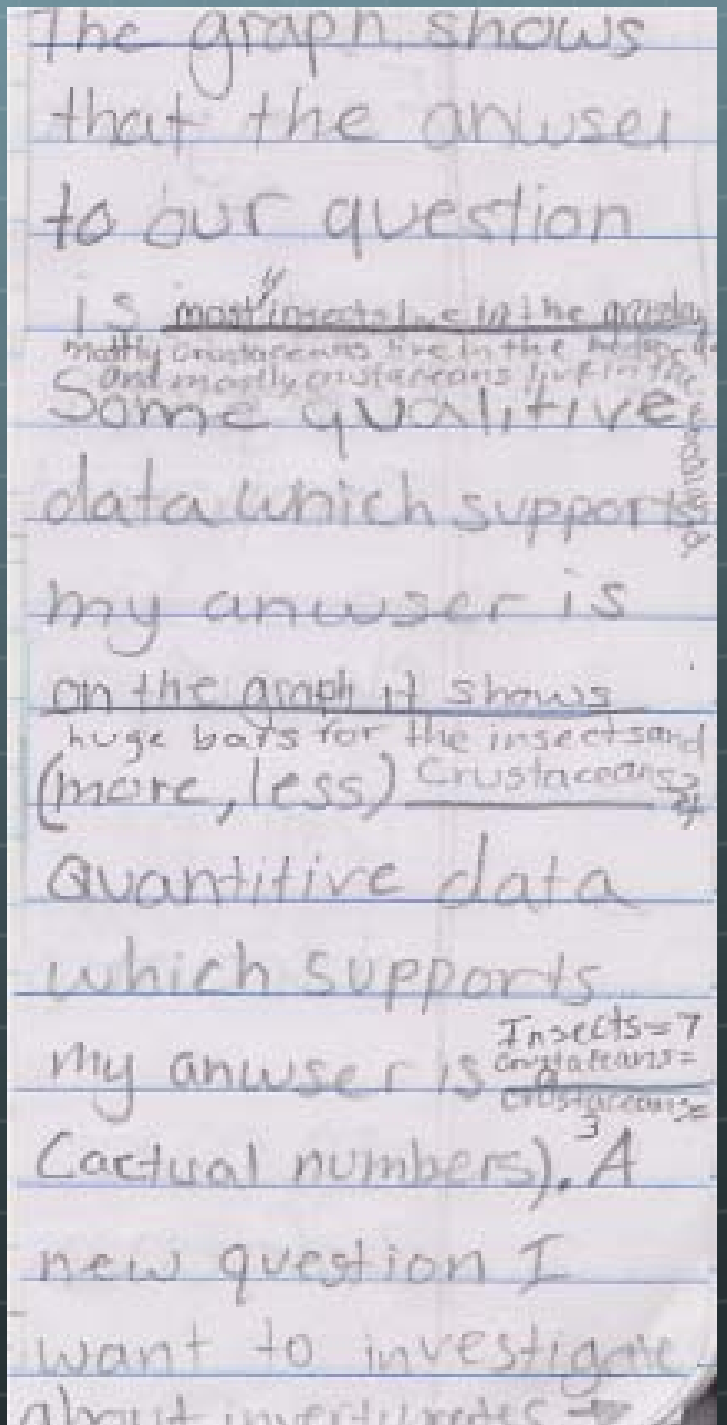
Invertibrate Observation

We noticed a huge spider web and in side a flower I noticed a spider so I told one of the guys in the group to get it so he just took off the flower and put it on the container. I noticed that the spider didn't move until we got into the school. The way we got the rolly polly's is when coen went into the hedge and got them into the main container. He also got the slug where the rolly polly's were.

Graphs with Data Analysis



Data Analysis


The graph shows that the anuser to our question is mostly insects live in the ocean, mostly crustaceans live in the water and mostly crustaceans live in the same qualitive data which supports my anuser is on the graph it shows huge bars for the insects and (more, less) Crustaceans quantitive data which supports my anuser is Insects=7 Crustaceans=3 (actual numbers). A new question I want to investigate

Sheltered STEM Lesson Sequence – Goals and Objectives

- STEM content lesson for MS (6-8)
- Lesson goals and objectives
- Content objectives
- Correlating NGSS or standards
- Language objectives
- Correlating ELP standards

Unit: Cloud and Wind Formation	**Lesson:** 2	**Essential Question:** How does the wind and rain associated with a hurricane form?

Standards Addressed

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions

ELP.6-8.5: conduct research and evaluate and communicate findings to answer questions or solve problems

ELP.6-8.8: create clear and coherent grade-appropriate speech and text.

Science and Engineering Practices: Planning and Carrying Out Investigations

Unit Objectives

- ✓ Students will apply their understanding of air masses and their interaction to weather formation.
- ✓ Students will apply their understanding of convection currents to wind formation.

Lesson Objectives

- ✓ I will describe how hot and cold air masses interact
- ✓ I will explain, using evidence, how wind is generated

Content Target Expressed in Academic Language

I predict that when hot and cold air masses collide, the hot air will rise up above the cold air. I think this will happen because I used smoke to watch warm air rise. This happened because warm air is less dense than cold air.

In order to test my prediction, we made warm and cold air collide. When hot and cold air collided, I observed the warm air rise, pulling the cold air into the tube underneath. The smoke showed air flowing from one tube to another. My observations show that the warm air is less dense, and when it rose it left room for the cold air to move underneath, creating a convection current of air.

My observations show that cold air always moves underneath warm air, creating wind currents. When air masses of different temperatures collide, wind currents form. For example, when warm air over the land collides with cold air over the ocean, wind forms. This is why it is often windy at the beach.

Language Forms and Functions

Descriptive
Interpretive
***Making arguments with supporting evidence (focus)**

Linguistic Structures

Wh- questions, past tense, embedded clauses with *because*

Academic Vocabulary

- collide
- prediction

Science Vocabulary

- hypothesis
- air mass
- convection current

Language Stems

I predict that when hot and cold air masses collide, _____.

I think this will happen because _____.

In order to test my prediction, I _____

When hot and cold air collided, I observed _____.

My observations show that _____.

For example, _____.

Unit: Cloud and Wind Formation	**Lesson:** 2	**Essential Question:** How does the wind and rain associated with a hurricane form?

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Language Forms and Functions

Descriptive

Interpretive

***Making arguments with supporting evide**
(focus)

Language Stems

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Language Forms and Functions

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Language Forms and Functions

Descriptive
Interpretive
***Making arguments with supporting evidence (focus)**

Linguistic Structures

Wh- questions, past tense, embedded clauses with *because*

Academic Vocabulary

- collide
- prediction

Science Vocabulary

- hypothesis
- air mass
- convection current

Language Stems

I predict that when hot and cold air masses collide, _____.

I think this will happen because _____.

In order to test my prediction, I _____

When hot and cold air collided, I observed _____.

My observations show that _____.

For example, _____.

Example STEM Lesson Sequence – Content-specific activities

Inquiry 5.1 Investigating the Effects of Colliding Air Masses

PROCEDURE

1. Collect one copy of Student Sheet 5.1a: When Air Masses Meet. Read the question at the top of the student sheet: What happens when two of the same—and then different—air masses meet? You will investigate this question during the inquiry.

2. Look at one set of connected Convection Tubes and the materials for each group. Then look at Table 1 on Student Sheet 5.1a. What are some ways you might set up this equipment to investigate the question in this inquiry? Discuss this with your class. One suggested setup is shown in Figure 5.1.

3. On your student sheet, make a list of the materials you will use and the procedures you will follow to test each setup. Be prepared to share your ideas with the class.

4. What will you keep the same in each setup? What will you change during each test? Write down your ideas on Student Sheet 5.1a.

5. What do you think will happen when cold, moist air meets cold, moist air? What do you think will happen when warm moist air meets warm moist air? What will happen when cold moist air meets hot dry air? Discuss your predictions with your group. Record what you think will happen in the Predictions column in Table 1 on your student sheet.

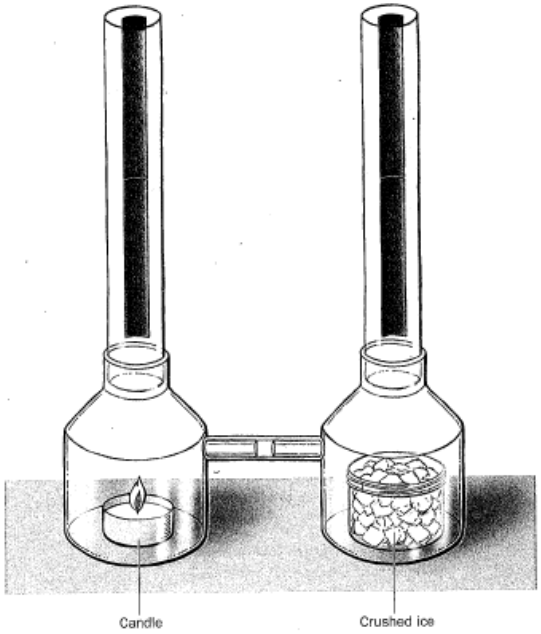


Figure 5.1 *Connected Convection Tubes*

6. Review with your teacher the following points, which you should keep in mind while you work:

   A. Keep the Convection Tubes connected at all times.

   B. Do not record any temperature changes in this lesson.

   C. Introduce smoke into the top of the cylinder, as shown in Figure 5.2.

7. Before you begin, review Safety Tips with your teacher.

8. Collect and set up your materials. Begin the investigation. Discuss your observations with your group as you work, and record them on your student sheet. For each setup, remember the procedures your group developed. Use your flashlight to see the smoke.

9. When you have finished testing all three conditions, clean up. Put out the burning punk by dipping just the tip of it in a cup of water. Cut off the wet tip with the scissors. Refill your container with crushed ice for the next class.

SAFETY TIPS

Roll up loose sleeves and tuck in loose clothing. Tie back long hair.

Do not let the burning punk touch the cylinder. The plastic cylinder will melt if it does.

Do not ask your teacher to light your candle until you are ready.

Do not reach across an open flame.

Do not leave the candle under the plastic cylinder for longer than 1 minute. The plastic will get hot.

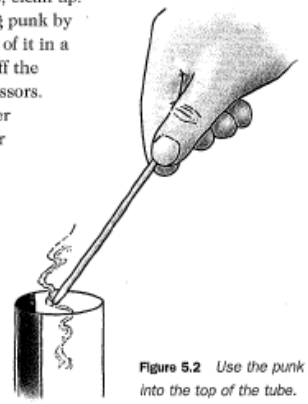
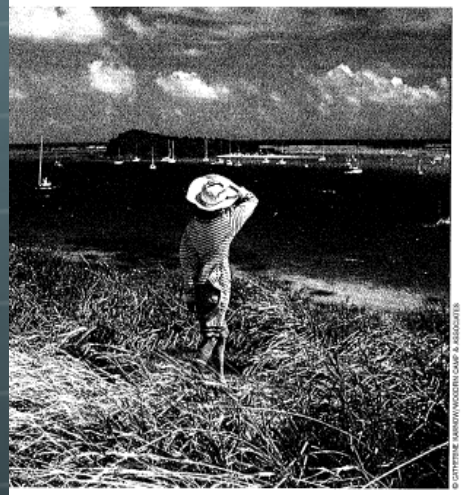


Figure 5.2 *Use the punk stick to introduce smoke into the top of the tube.*

Example STEM Lesson Sequence – Language-specific activities

LESSON **5**

Convection Currents in the Air



Hold on to your hat! Whether you are walking along a beach or flying a kite in an open field, a really windy day can make you feel like you are about to be swept off your feet. Breezes occur because of the different rates at which land and water heat and cool.

INTRODUCTION

What causes the wind to blow? Mostly, it has to do with the uneven heating of the earth. Breezes occur because land and water heat and cool at different rates.

When the sun's energy heats the earth, the temperature of the air above the earth's surface changes. Air, warmed by the surface below it, starts to rise, and cool air moves in to take its place. This circulation of air causes changes in the weather, including the formation of winds.

In this lesson, you will connect two of the Convection Tubes you used in Lesson 4. What happens when two masses of air with the same temperature and humidity meet? What happens when air masses of different temperature and humidity conditions meet? After observing the movement of air in the convection model you set up, you will apply what you have learned to two real-world situations. You will analyze how land breezes and sea breezes form and how tornadoes develop in the United States.

OBJECTIVES FOR THIS LESSON

Set up an investigation that demonstrates what happens to two air masses when they meet.

Analyze the movement of two air masses with different temperature and humidity conditions.

Devise working definitions for the terms "convection current" and "weather front."

Relate the movement of air within the convection model to the formation of land and sea breezes and the development of tornadoes.

Explain how winds form.

Key Content Vocabulary

- Identifying key content vocabulary

  - Academic vocabulary: collide, prediction

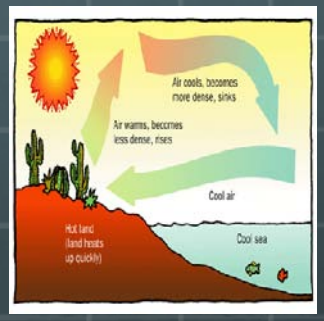
  - Science-specific vocabulary: hypothesis, air mass, convection current, circulation of air

Vocabulary-Specific Activities

- Pre-teaching key-content vocabulary (using visuals and images) – also *highlight* these words in the text for textual input enhancement.

Collide:

Convection current:



- Strengthening the understanding of the key-content vocabulary using 4-columns of vocabulary chart

New word	Definition	Picture	Knowledge Connections

Key Linguistic Structures

- Identifying key linguistic structures and sentences:

(1) Wh- questions for "prediction."

What happens when hot and warm *air masses collide*?

I predict that when hot and cold air masses collide, the hot air will rise up above the cold air.

(2) Making arguments using "because –"

The hot air will rise up above the cold air *because warm air is less dense than cold air.*

(3) Stating observations using past tense verbs

When hot and cold air *collided*, I *observed* the warm air rise, pulling the cold air into the tube underneath. The smoke *showed* air flowing from one tube to another.

Key Linguistic Structures Practice

- **Stating predictions using leveled sentence frames/starters (depending on language proficiency; chosen by ELs)**

Q: What do you think will happen when cold moist air meets hot dry air?

A: I predict that _____ *will* _____.

- **Making arguments using "because-"**

Q: What do you think will happen when cold, moist air meets hot dry air?

A: I predict that _____. (high-level language proficiency)

I predict that _____ *will* _____ *because* _____. (mid-level language proficiency)

I predict that _____ *will* _____. Warm air is less dense than cold air. (lower language proficiency)

- **Stating observations**

Q: What did you observe when the tubes contained air with different temperature and humidity conditions?

A: My observations show that _____. (high-level language proficiency)

I observed that _____. I think this happened because _____. (mid-level language proficiency)

I observed that warm air _____. Warm air is less dense than cold air. . (lower language proficiency)

Key Language Functions

- Making predictions (ELs should be able to complete sentences of predictions in classroom discourse as well as in writing).
- Making arguments with supporting evidence or examples (ELs should be able to make a proper argument and support their claim based on their predictions and observations both orally and writing).
- Stating observations (ELs should be able to state what they actually observed both orally and in writing).

Example STEM Lesson Sequence – Content Assessment

REFLECTING ON WHAT YOU'VE DONE

1. Answer the following questions. Discuss your observations with the class.

A. What did you observe when both tubes contained air with the same temperature and humidity conditions? Why do you think this happened?

B. What did you observe when the tubes contained air with different temperature and humidity conditions? Why do you think this happened?

C. On the basis of your results from Lessons 4 and 5, under what conditions do you think winds and rotating storms might form?

2. Look again at the illustration in "Air Masses" (Lesson 4). Where in the United States do you think air masses with different temperature and humidity conditions might meet? The boundary that forms when this happens is called a weather front. What type of weather do you think might occur along a front?

3. A convection current formed when you set up the Convection Tubes so that a hot air mass collided with a cold one. Use your experiences to write your own definitions for the terms "convection current" and "weather front." Discuss your definitions with the class.

4. Read "Why Does the Wind Blow?" on pages 59–62 and "Weather Fronts" on page 63. Revise your definitions if needed.

5. Your teacher will ask you to complete Student Sheet 5.1b: Convection on the Earth to find out what you know about how air moves. On this sheet you will do these steps:

- Illustrate how air moved in your group's Convection Tube.
- Relate the movement of air within your convection model to the formation of land and sea breezes.
- Apply the movement of air within your convection model to the development of tornadoes.

Example STEM Lesson Sequence – Language Assessment

- Criteria for language assessment: Vocabulary, Linguistic structures and Language functions
- Vocabulary: Students can define key-content vocabulary, particularly, science vocabulary both orally and in writing
- Linguistic structures (forms): Students can complete sentences using the (leveled) sentence frames provided to them.
- Language functions: Students can demonstrate their understanding of three distinctive language functions correlating with the lesson (i.e., making predictions, making arguments, and stating what they observed).

Conclusion: Integration of Language and Content

- Why integration is necessary?

  Language-focused learning activities enable ELs to comprehend the STEM lesson more clearly, and build better understanding of core STEM concepts. Also, these activities help facilitate ELs' language development for general academic discourse; CCSS and NGSS focus on language competence as well, so it is important to address language needs of ELs even in STEM content subjects.

- To what extent should language and literacy be integrated?

  As much as possible, and to the extent necessary. STEM teachers should at least be prepared to explicitly teach key vocabulary and language concepts *before and during* content-related learning activities.

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