*The Connectivity of Mathematics to Science in Elementary School

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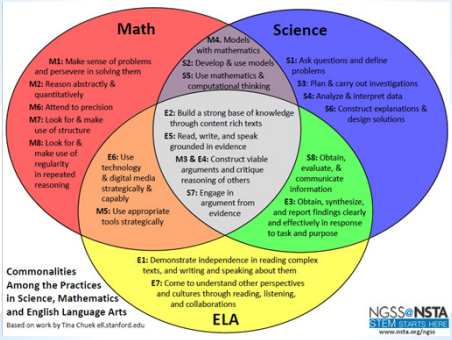
*Importance of Integration

- *Effects students' lives forever - the long term positive impact
- *Helps students develop their confidence and ability in mathematics and science
- *Helps preparing students as competitive global citizens



*Crosscutting Concepts (NGSS)

- *Patterns
- *Cause & Effect
- *Scale, Proportion, and Quantity
- *Systems & System Models
- *Energy & Matter
- *Structure & Function
- *Stability & Change

*Science & Engineering Practices (NGSS)

- *Asking questions and Defining Problems
- *Planning and Carrying Out Investigations
- *Analyzing and Interpreting Data
- *Developing and Using Models
- *Constructing explanations and Designing Solutions
- *Engaging in Argument from Evidence
- *Using Mathematics and Computational Thinking
- *Obtaining, Evaluating, and Communicating Information

*Backward Design Lesson Planning (NGSS)

- ✓ Standards
- ✓ Learning objectives
  - Guiding Questions
- ✓ Assessment
- ✓ Lesson Activities

Plan in this order!!!

*As you plan, think about . . .

- *What do we know?
- *How do we know?
- *What is the evidence?
- *Why should we care???

STEM

*Conceptual Change Model (CCM)

Developed to encourage genuine learning - bring about change with respect to a concept.

There are several conditions needed to be present in students to encourage this change:

- ✓ dissatisfaction with existing views,
- ✓ plausibility of new concept,
- ✓ attractiveness of new concept, and
- ✓ explanatory and predictive power of new concept.

*How CCM takes students through various steps to reach genuine learning?

- * Students are first asked to become aware of their own thinking.
- * They are then taken through a series of steps to have them confront their ideas and refine them if necessary.
- * Their new understanding is then used and finally asked to make connections to other subjects and their lives. (Stepans et al.,2005)

*Benefits

- * useful for helping students of diverse learning styles and capabilities
- * effective in establishing a more comfortable, collegial classroom atmosphere for more students.
- * effective in helping to identify and overcome specific problem areas
- * actively promotes both student and teacher metacognition. (Stepans et al., 2005. p. 41)

*Goal of CCM

Students will . . .

Know → Do → Care About

their learning

*Remember!

A	• Activity	C	• Concept
B	• *Before*	B	• *Before*
C	• Concept	V	• Vocabulary

*Science and Math Integration: Snowflakes

*NGSS

*_Disciplinary Core Idea:_ 2-PS1-1: Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.

*_Crosscutting Concept:_ Patterns; Energy & Matter

*_Science and Engineering Practices:_ Constructing Explanations and Designing Solutions

*Science and Math Integration: Snowflakes

CCSS-MATH

*_CCSS.MATH.CONTENT.2.GA.1:_ Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces.[1] Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

*Science and Math Integration: Snowflakes

CCSS-ELA

*_CCSS.ELA-LITERACY.RI.2.6:_ Identify the main purpose of a text, including what the author wants to answer, explain, or describe.

*Snowflakes!

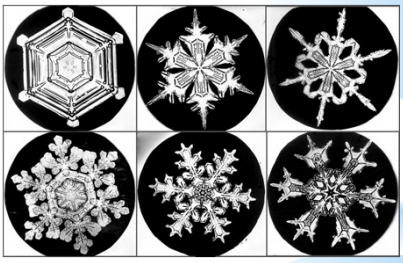
*Have you ever seen snow? Where?

*Have you examined individual snowflakes?

*Snowflakes!

CCM: Commit to an Outcome

*Carefully examine the snowflake photos provided. What patterns do you see? List them.



*Snowflakes!

CCM: Expose Ideas

*Share your ideas with your group. Choose one person to present your group's ideas to the class.

*Snowflakes! (continued)

CCM: Confront Ideas

*How can you create paper snowflakes with similar properties to those you observed at the website?

*Use the copy paper provided to create a paper snowflake.

*Make sure your snowflake has properties like the ones at the website.

*Snowflakes! (continued)

*Snowflakes! (continued)

CCM: Confront Ideas

*Describe your snowflake in words in your science notebook.

*Compare your snowflake with those made by others in your group.

*Why are they different? Are any exactly the same?

*Snowflakes! (continued)

(CCM: Extend Ideas):

- How do you think snowflakes are classified?

*Examine the snowflakes at the website provided.

  *How would you classify them? Describe each group you identified.

  *Do any of the snowflakes not fit the groups you made?

*Let's read about Snowflake Bentley, the man who photographed snowflakes. Where do you think he lived?

*As we read the story, think about problems he overcame in photographing snowflakes.

*What happened to the snowflakes Snowflake Bentley photographed?

*Snowflakes! (continued)

(CCM: Extend Ideas):

*How do you think snowflakes form?

*What causes the special shapes?

*Let's watch a video to find out more.

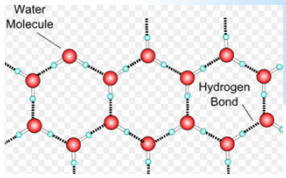
Beyond:

What questions do you still have about snowflakes? How could you find the answers to your questions?

*Science and Math Integration

*Snowflakes Lesson:

*While no two snowflakes are exactly the same, they are hexagonal shapes due to the molecular structure of ice.



*Each water molecule is made of two hydrogen atoms bonded to one oxygen atom.

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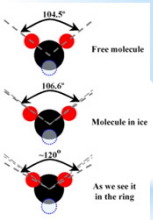
Science and Math Integration

- Snowflakes Lesson:
  - As water freezes, the molecules are forced to align themselves into a very particular structure – a hexagonal lattice that is the basis for the six-sided snowflakes.
  - Electrical forces between hydrogens and lone pairs widens the opening angle of the water molecule to 106.6.
  - The molecule rotates up and the angle appears to be about 120.



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Science and Math Integration: Pennies

- NGSS
  - *Disciplinary Core Idea: MS-PS1-3:* Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
  - *Crosscutting Concepts: Patterns;* Structure & Function
  - *Science & Engineering Practices:* Analyzing & Interpreting Data

Science and Math Integration: Pennies

CCSS-MATH

- *CCSS.MATH.CONTENT.6.SP.B.4:* Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

Comparing Pennies

On your own, think of and write down your answer to the following situation.

I collected 30 pennies over the period of a few days. I was curious to see how consistent the penny manufacturing process was. I used a scale from the Chemistry Department to weigh my 30 pennies. Here are the data (in grams):

2.57	2.56	3.14	3.03	3.13	2.47	2.43	3.11	3.06	2.48
2.51	2.50	3.07	3.08	3.01	2.45	2.50	3.13	2.51	3.12
3.10	3.08	2.46	2.44	2.47	2.54	3.09	3.13	2.56	2.49

What can you tell about how consistent the penny manufacturing process was by just looking at the raw data?

Comparing Pennies

- Share your answer with others in your group. Ask a member of your group to write down and share everybody's ideas with the rest of the class.
- Using the handout provided, fill in the Frequency/Relative Frequency Table and the Histogram.
- Discuss your table and histogram with your group members.

Comparing Pennies

Ask a member of your group to share the results and procedures of their discovery activity with the class.

Questions:

1. Are there any situations/problems that would require the same process we used?
2. How does this connect with other problems we have done in class?

*Comparing Pennies

Questions:

1. Do any of you have questions concerning the process used to arrive at the answers?
2. Do you have comments or insight about how to apply what we did today?
3. What are some new questions or problems that relate to this situation you would like to explore?

*Conditions to consider for integrating mathematics and science?

1. The lesson or unit should complement or support some aspect of instruction in the subject area.
2. The lesson or unit should complement or support the content and/or learning skills in at least one other subject field.
3. The lesson or unit should be constructed in a manner that encourages students to integrate and use the new knowledge and skills from several areas of competence.

(Robinson, 1994).

*Best practices for teaching Math & Science

1. use manipulatives/hands-on (make learning concrete and active)
2. use cooperative group work
3. use discussion and inquiry
4. use questioning and making conjectures
5. use justification of thinking

(Zemelman, Daniels, & Hyde, 2005)

*Best practices for teaching Math & Science

6. use writing for thinking, feelings, and problem solving
7. use problem-solving approach to instruction, making content integration a part of instruction
8. use technologies such as calculators and personal computers
9. promote the role of the teacher to that of a facilitator of learning
10. use assessment as a part of instruction.

(Zemelman, Daniels, & Hyde, 2005),

*Teaching Integrated Mathematics & Science

1. "Base integration on how students experience, organize, and think about science and math.
2. Take advantage of patterns as children from the day they are born are looking at patterns and trying to make sense of the world.
3. Collect and use data in problem-based integrated activities that invoke process skills.

(Furner & Kumar, 2007, p. 187)

*Teaching Integrated Mathematics & Science

1. Integrate where there is an overlapping content in math and science.
2. Be sensitive to what students believe and feel about math and science, their involvement and the confidence in their ability to do science and math.
3. Use instructional strategies that would bridge the gap between students' classroom experiences and real-life experiences outside the classroom."

(Furner & Kumar, 2007, p. 187)

*Discussion Questions

1. What do you do to integrate math and science in their classrooms?
2. What challenges do you face with when teaching integrated math and science lessons?

*Thank You!

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