Science, Literacy and Language Development Through Hands-on Science

Kenneth Wesson
Educational Consultant: Neuroscience
San Jose, CA
kenawesson@aol.com

- Virginia Association of Science Teachers
- Virginia Science Leadership Learning Association
- Virginia STEM Conference
- Hampton University – School of Pharmacy
- Longwood University
- University of Richmond
- Summer Institute for the National Academy of Sciences

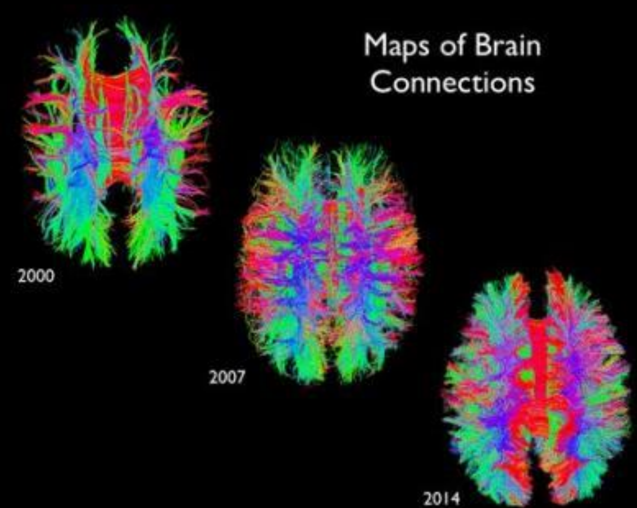
Science, Literacy and Language Development Through Hands-on Science

- What are the **“best teaching/learning practices”** for enhancing student success with the NGSS (science standards) as well as the **language/literacy** standards (CCSS ELA)? - **Interdisciplinarity**
- What is the **ST^{2}REAM** model of learning and why is it more effective than the traditional approach of education (delivering “siloed” academic content)?
- How do *I* start off the school year as an *unknown* to my students and end up as an *unforgettable?*

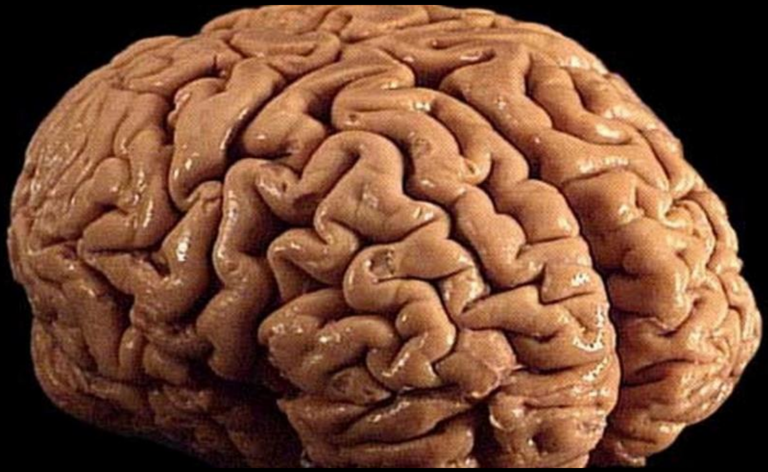
…a visual and conceptual tour…

- Knowing ***who*** you teach (a child with 100B neurons capable of making an infinite number of learning **connections** for a lifetime) is just as important as ***what*** you teach (disciplinary content).

- **“I teach science.” No, you teach *students* whose brains prefer to learn by actively making elaborate connections.**



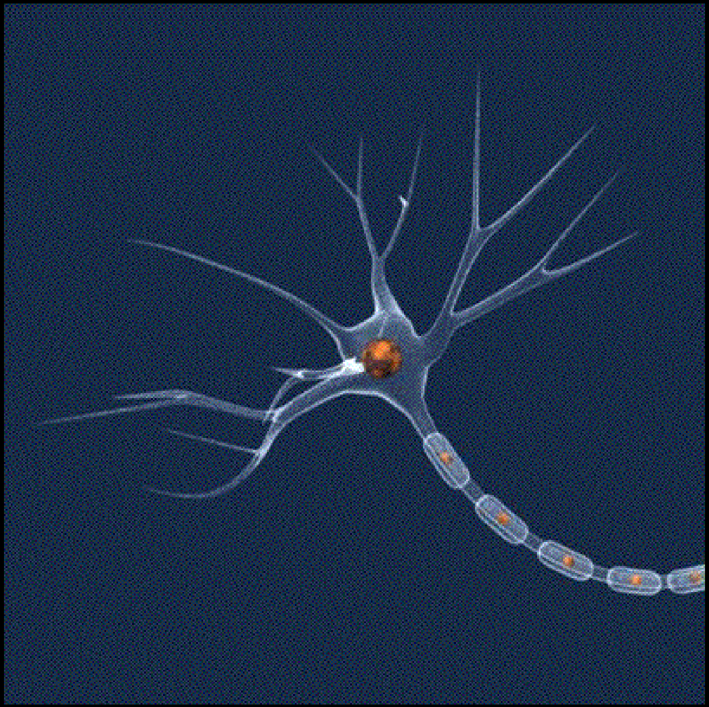
Brain Science: Making Connections



Experience the World

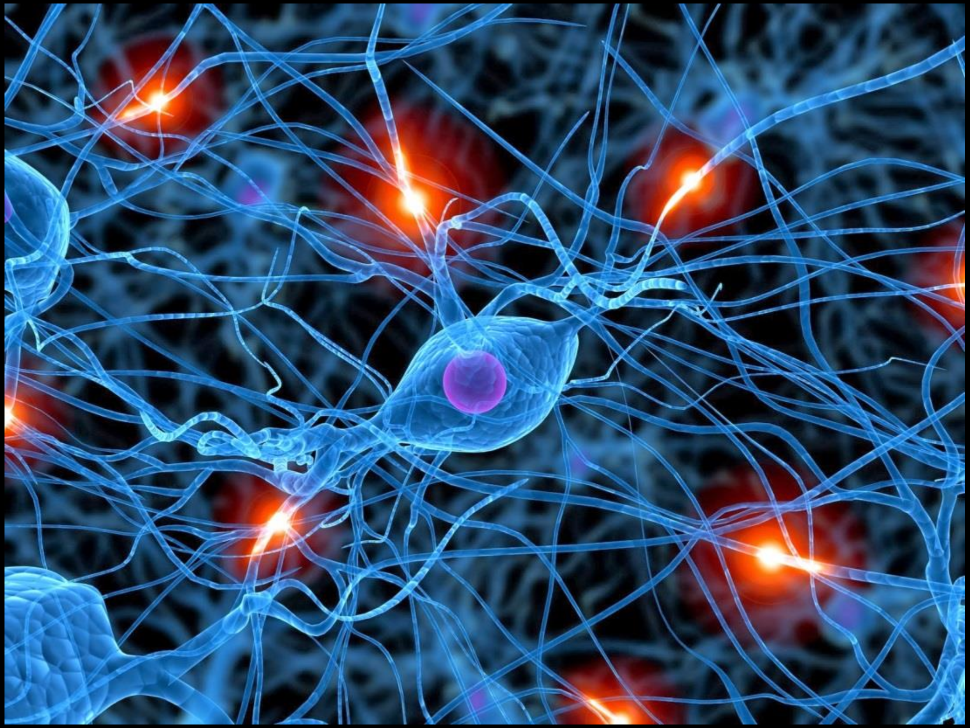
24/7 we translate our interactions *with* the world into the chemical language of the brain, and create circuits that represent what we have experienced

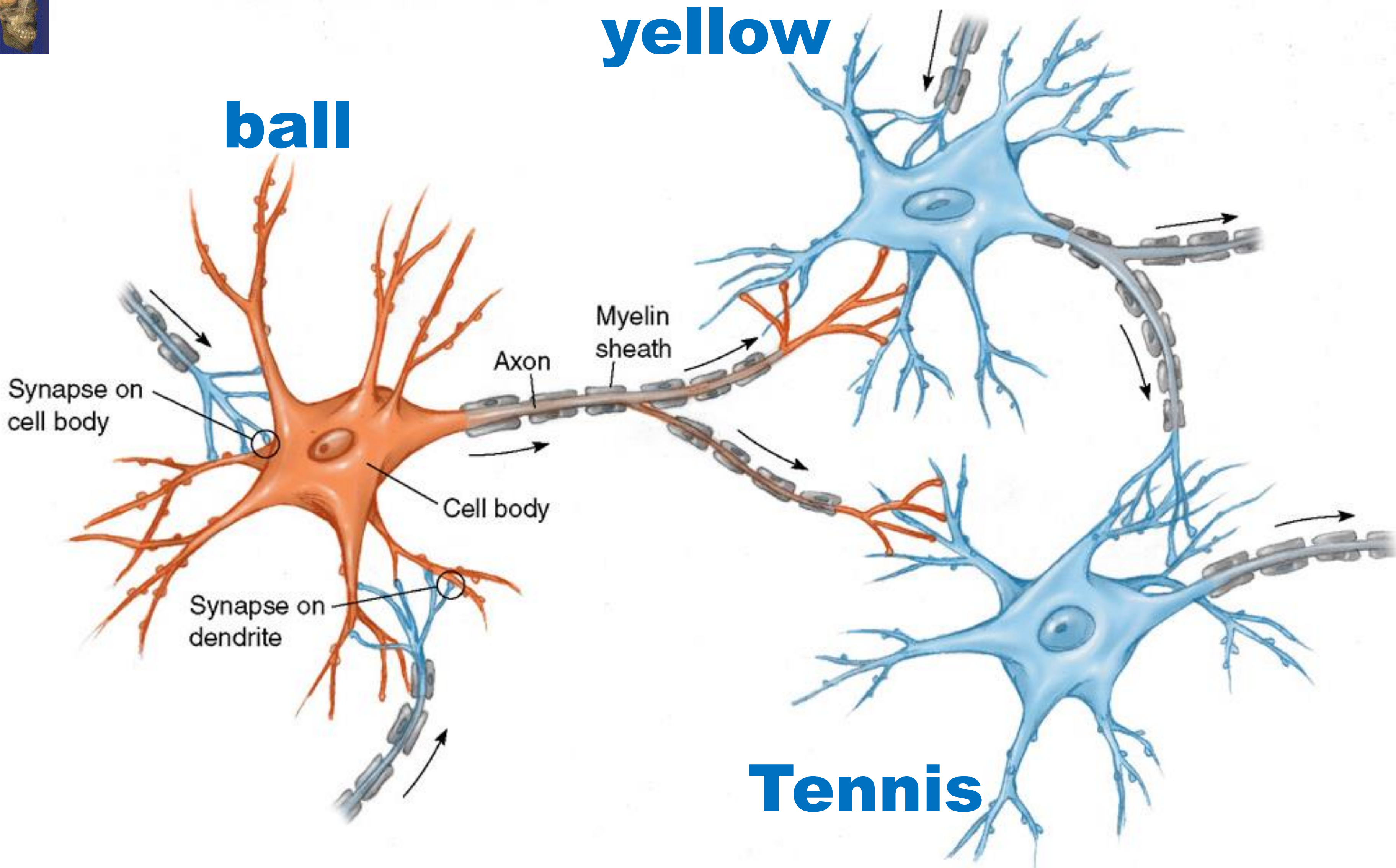
The Science of Learning: Making Connections



Neuron sending an e-message down the axon)

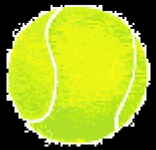
Ensemble of neurons





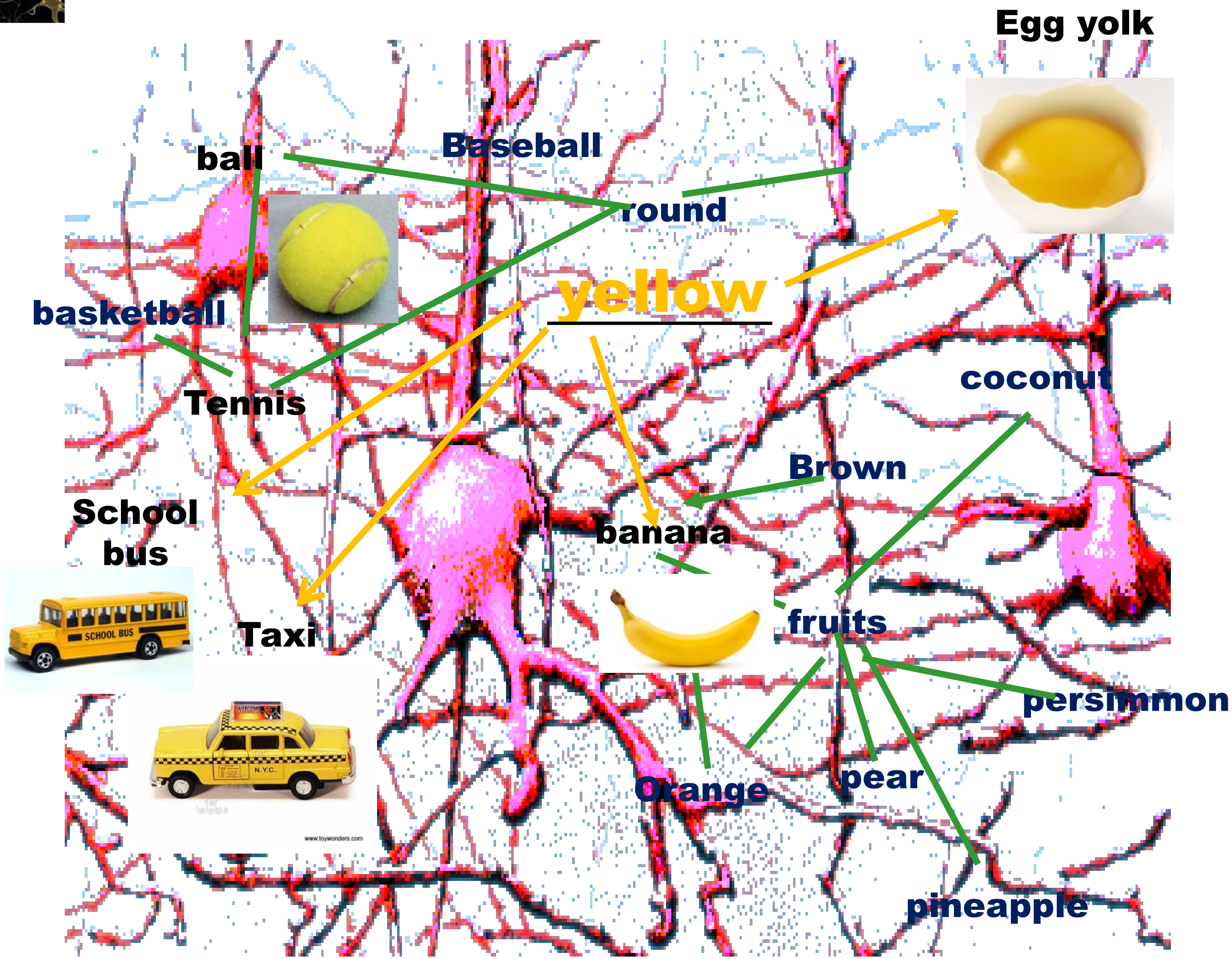
Prior to learning what a "yellow tennis ball" is, the *excitatory* neurons (brain cells) that are most prone to responding to *each* of these single elements already exist and they are anxiously awaiting activation (to "fire"). They only need *an experience* that will link them together.

The Science of Learning: Making Connections



Experience → builds the representative network

Distributed Networks: Making Connections



The “Use it or lose it” principle.

Developing Early Literacy through Active Learning

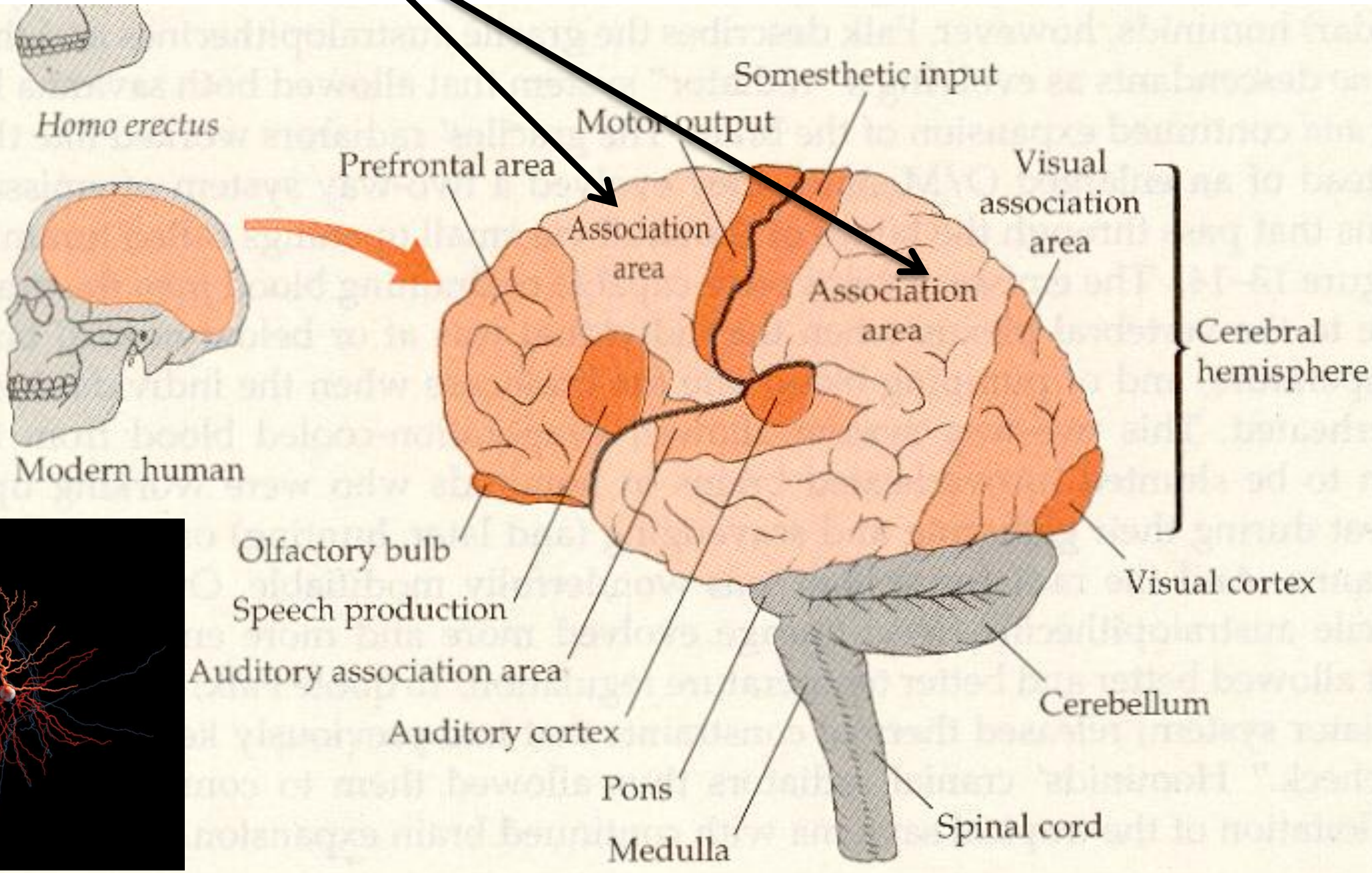
Schema theory: "mental file folders" of categorical information (animals, furniture, needles, etc.) → inside each folder → categorical contents (similar to "slips of paper") – a.k.a. *semantic features* (anything that would/should fall into the *category.)*

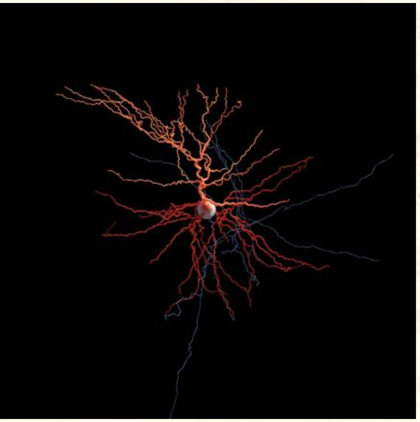
Adding *new information* or *"knowledge"* = adding more "slips of paper" into that flexible schema folder → "slot filling," which is how vocab. dev./cognitive growth occur.

Connect the *new word* with a *term/word/concept* that the student already knows by *"labeling"* the new information

("Instead of the word *rain,* we will now try to use the word *precipitation*) -- AL

The Association Cortices Make up 37% of the Human Cerebral Cortex





ST²REAM

Science

Technology (and Thematic trans-disciplinary instruction to extend student learning)

Reading and Language Arts

Engineering (“Design *and* Engineering”)

Art

Mathematics

(Maximizing connections and sensory experiences)

Standards from Which Discipline: Math or Science?

1. Asking questions and defining problems (NGSS)
2. Obtaining, evaluating, and communicating information (NGSS)
3. Look for and make use of structure (M)
4. Planning and carrying out investigations (NGSS)
5. Attend to precision (M)
6. Analyzing and interpreting data (NGSS)
7. Model with mathematics (M)
8. Using mathematics and computational thinking (NGSS)
9. Constructing explanations and designing solutions (NGSS)
10. Make sense of problems and persevere in solving them (M)
11. Reason abstractly and quantitatively (M)
12. Construct viable arguments and critique the reasoning of others. (M)
13. Developing and using models (NGSS)
14. Engaging in argument from evidence (NGSS)
15. Use appropriate tools strategically (M)
16. Look for and express regularity in repeated reasoning (M)

Practices in Mathematics, Science, and English Language Arts*

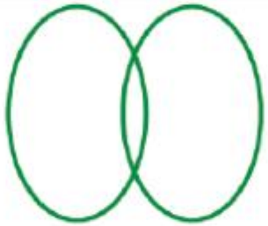
Math	Science	English Language Arts
M1. Make sense of problems and persevere in solving them.	**S1.** Asking questions (for science) and defining problems (for engineering).	**E1.** They demonstrate independence.
M2. Reason abstractly and quantitatively.	**S2.** Developing and using models.	**E2.** They build strong content knowledge.
M3. Construct viable arguments and critique the reasoning of others.	**S3.** Planning and carrying out investigations.	**E3.** They respond to the varying demands of audience, task, purpose, and discipline.
M4. Model with mathematics.	**S4.** Analyzing and interpreting data.	**E4.** They comprehend as well as critique.
M5. Use appropriate tools strategically.	**S5.** Using mathematics, information and computer technology, and computational thinking.	**E5.** They value evidence.
M6. Attend to precision.	**S6.** Constructing explanations (for science) and designing solutions (for engineering).	**E6.** They use technology and digital media strategically and capably.
M7. Look for and make use of structure.	**S7.** Engaging in argument from evidence.	**E7.** They come to understanding other perspectives and cultures.
M8. Look for and express regularity in repeated reasoning.	**S8.** Obtaining, evaluating, and communicating information.	

* The Common Core English Language Arts uses the term "student capacities" rather than the term "practices" used in Common Core Mathematics and the Next Generation Science Standards.

NGSS@NSTA
STEM STARTS HERE

Taught in the domain of Science or ELA?

Text Structure Signal Questions & Signal Words

Cause and Effect	Compare and Contrast	Sequence	Problem and Solution	Description
				
Signal Words				
So Because Since Therefore If…then This led to Reason why As a result May be due to Effect of Consequently For this reason	Same as Similar Alike As well as Not only…but also Both Instead of Either…or On the other hand Different from As opposed to	First Second Next Then Before After Finally Following Not long after Now Soon	Question is… Dilemma is… The puzzle is… To solve this… One answer is… One reason for the problem is…	For instance Such as… To begin with An example To illustrate Characteristics *Look for the topic word (or a synonym or pronoun) to be repeated

Similar Concepts, Discipline-specific Terminology

Reading	Mathematics	Science
Listening, speaking, reading/researching, writing	*Listening, speaking, reading, writing*	*Listening, speaking, reading/researching, writing*
Predict	Estimate	Hypothesize, predict
Identify	Find the…	Observe, investigate
Compare and contrast	Difference, sorting, quantifying	Classify → sense-making
Sequence (chronology)	Order and magnitude	Organize and categorize
What is the main idea?	Solve for…	What is the key concept?
List the…	Chart/graph the	Record and interpret the data
Summarize the	What is the…?	What conclusion can you draw?
List your reasons for	Show your work	What evidence supports your claim?
Cause and effect	Ratios and relationships	Cause and effect, cycles, systems
Sense-making, reasoning	Number sense	Claims and evidence, reasoning
Argumentation	Proofs	Arguments and evidence
Questions	Problems	Investigations (and Inquiry)
Proposition-answer	Problem-solution	Question-experiment
Descriptive skills dev.	Quantitative skills dev.	Thinking skills dev.; applications
Content focus	Focus on Problem-solving	Focus on answering questions
Words for expression	Words, numbers, symbolic Expressions	Written, visual, numerical, symbolic Expression and applications
Critical thinking	Quantitative and logical thinking	Creative thinking

Commonalities in CCSS & NGSS

ELA Features

- Reading for **Literature** (10 standards)
- **Reading** for **Informational Text** (10 standards)
- Foundation (4 standards – K-5 only)
- **Writing** (10 standards)
- **Language** (6 standards)
- **Speaking and Listening** (6 standards)

Balance between informational text and literature

Writing in response to texts (events, experiences, etc.)

Conducting and reporting on research

Cross-content literacy (transdisciplinary)

Pheno-BL

Common Core (E/LA and Math), ELD, STEM,

and the new Science Standards (NGSS):

Standards correlations → overlapping

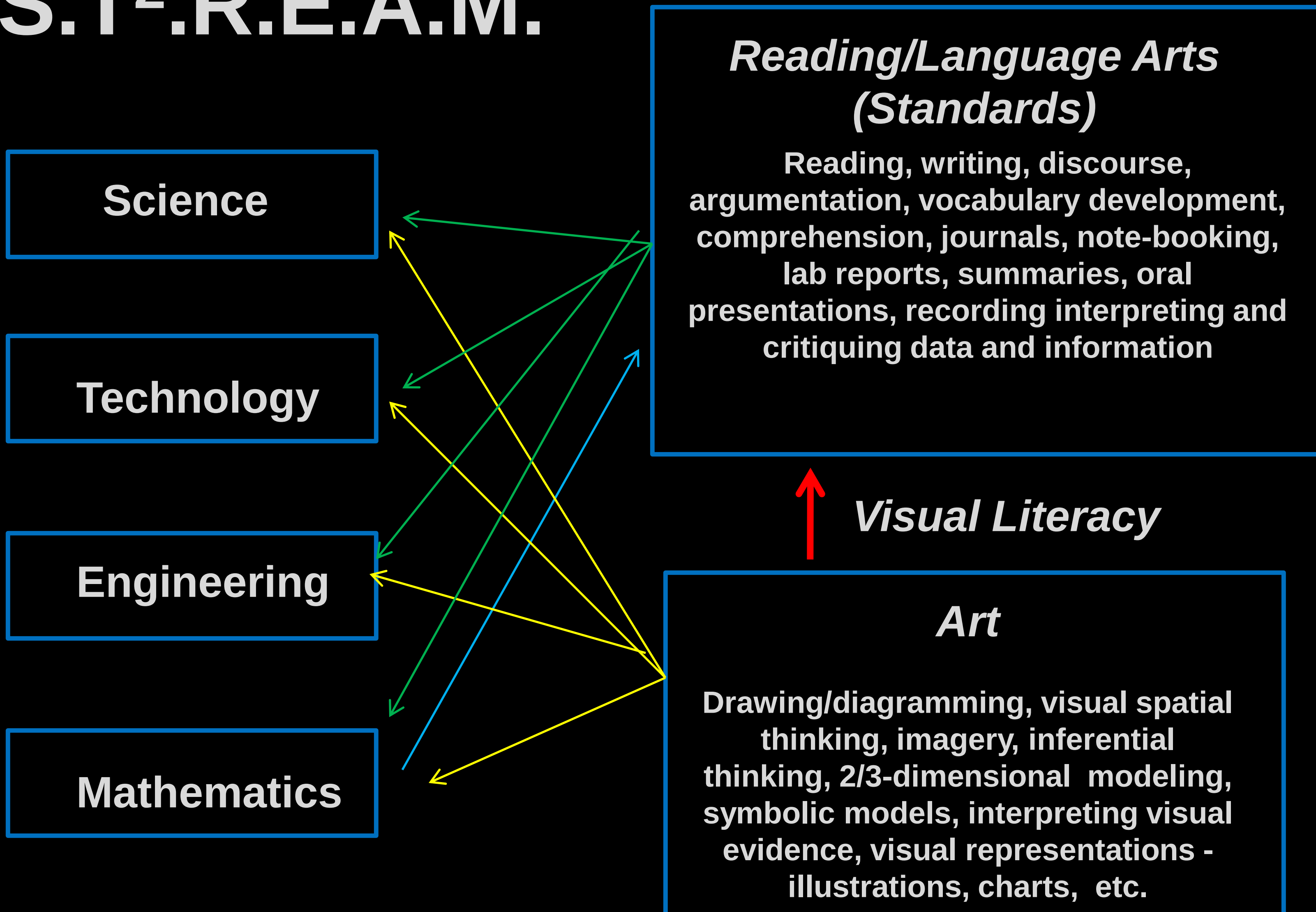
- **standards**
- **content**
- **concepts**
- **student learning objectives**
- **language goals and vocabulary**

One of the great ironies of formal education is that we expect students to put the various the pieces of the curriculum together into something we call real-world knowledge that can be applied after they graduate, although we make no claim that we ever showed them *how* during the first thirteen years.

You will be planning, designing, and making each of the objects, structures or products listed below. Which of them require the skills that are developed in the STEM/STREAM subjects?

Object	Science	Technology	Reading (ELA)	Engineering	Art/ Design	Math
Running shoes	•	•	•	•	•	•
Skateboard park	•	•	•	•	•	•
Non-tipping Kayak	•	•	•	•	•	•
Backpack	•	•	•	•	•	•
New i-Pod	•	•	•	•	•	
Amusement park	•	•	•	•	•	•
Amusement park rides	•	•	•	•	•	•
Racing bike	•	•	•	•	•	•
Sunglasses	•	•	•	•	•	•
Electronic game	•	•	•	•	•	•

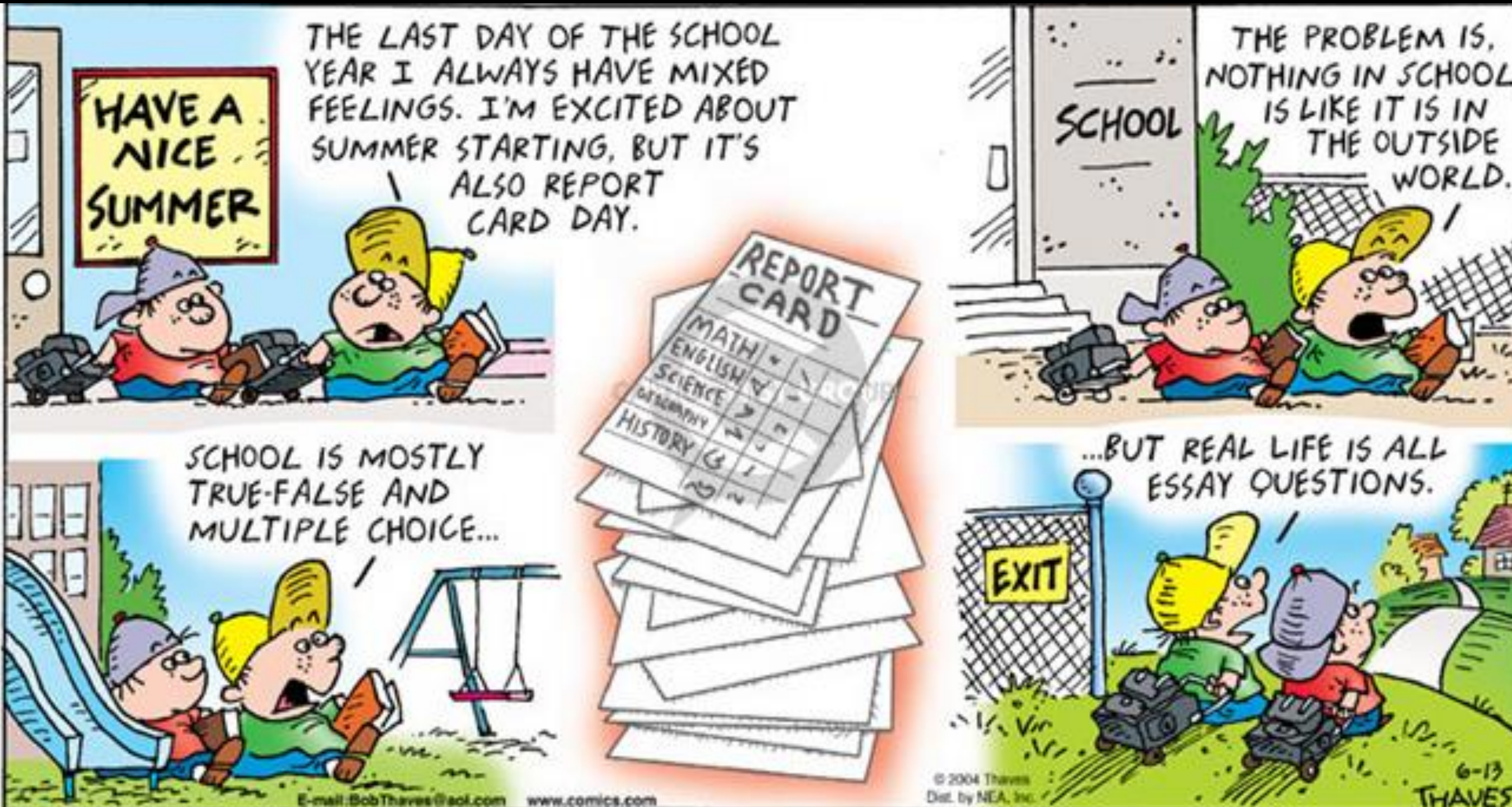
S.T^2.R.E.A.M.



<u>Convergent/Integrative</u> STEM T' & L'


HAVE A NICE SUMMER
THE LAST DAY OF THE SCHOOL YEAR I ALWAYS HAVE MIXED FEELINGS. I'M EXCITED ABOUT SUMMER STARTING, BUT IT'S ALSO REPORT CARD DAY.
REPORT CARD
MATH
ENGLISH
SCIENCE
SCHOOL
THE PROBLEM IS, NOTHING IN SCHOOL IS LIKE IT IS IN THE OUTSIDE WORLD.

S.T^2.R.E.A.M.


HAVE A NICE SUMMER
THE LAST DAY OF THE SCHOOL YEAR I ALWAYS HAVE MIXED FEELINGS. I'M EXCITED ABOUT SUMMER STARTING, BUT IT'S ALSO REPORT CARD DAY.
REPORT CARD
MATH
ENGLISH
SCIENCE
HISTORY
SCHOOL
THE PROBLEM IS, NOTHING IN SCHOOL IS LIKE IT IS IN THE OUTSIDE WORLD.
SCHOOL IS MOSTLY TRUE-FALSE AND MULTIPLE CHOICE...
...BUT REAL LIFE IS ALL ESSAY QUESTIONS.
EXIT
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6-13
THAVES

Schools vs. the Real-world

(“Interdisciplinarity is like real life”)

“…school learning is abstract, theoretical and organized by disciplines, while work in the real world is concrete, specific to the task, and organized by problems/projects…” ***not by disciplines.***

-- Organisation for Economic Co-operation and Development (*OECD*), “Learning for Jobs” (2009)

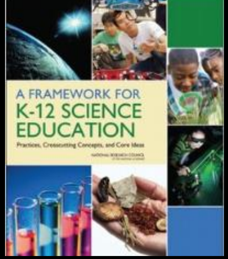
ICLE: Application Model

1. ~~Knowledge in one discipline~~
2. ~~Application within one discipline~~
3. ~~Application *across* disciplines~~
4. Application to real-world *predictable* situations
5. Application to real-world *unpredictable* and/or creative situations where the focus is on applications of knowledge ("improvisational intelligence")

"Nothing is more dangerous than an idea, when it's the only one your have."

If they don't learn the way you teach, then

why not teach* the way *they learn?



20+ Years of Research in Cognitive Science: *High Impact Learning Strategies*

1. **People learn and remember best through real-world first-hand experiences, not memorization.**
2. **Children are born investigators.**
3. **Understanding builds over time (knowledge is *cumulative* and occurs over extended periods of time – "distributed learning")**
4. **We attempt to "make sense" of all incoming stimuli through the senses, visualization, and through formal language (AL).**
5. **Science and Engineering require both content knowledge *and* knowledge of effective practices (SEPs: thinking, knowing and doing - applications)**

1. **Engagement, *then***
2. **Language development**

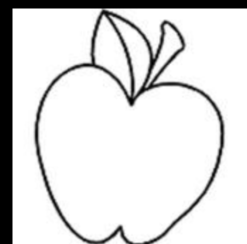
The real cause of failure in formal education is essentially the fact that one begins with *language,* instead of beginning with *real and material action*. (Piaget, 1976)

The brain moves best from ***meaning*-to-print,** rather than from ***print*-to-meaning**

1st hand

CONCRETE

2nd hand



Visual represen-tation (VST)

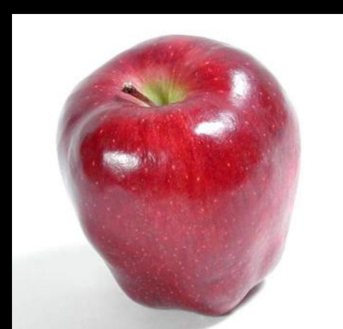
3rd hand

APPLE

SYMBOLIC/ ABSTRACT

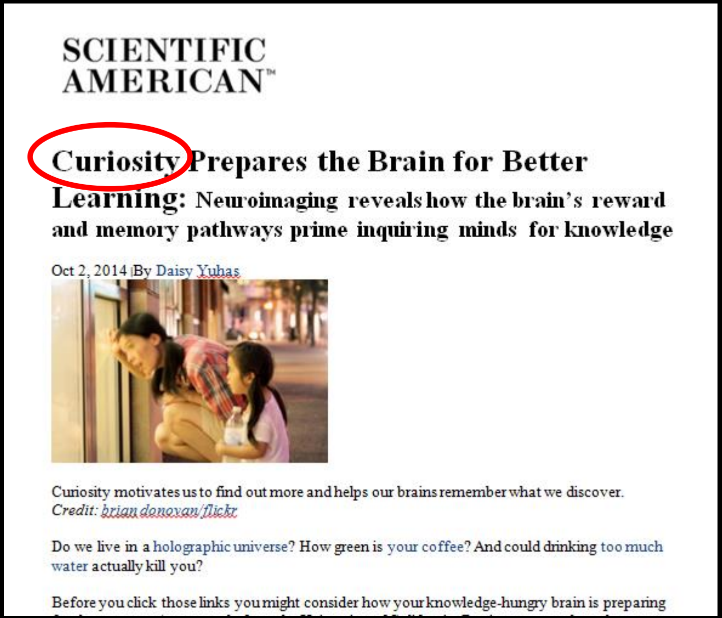
The most difficult means by which the developing brain learns

cognitive *rehearsals* →



Phenomenon-based Science
(Promotes Student Engagement)

"Student engagement" is predicated on the research indicating that learning is enhanced when students are curious, involved, and enthusiastically receive ongoing feedback from *the activity* itself (not the teacher).


SCIENTIFIC
AMERICAN™

Curiosity Prepares the Brain for Better Learning: Neuroimaging reveals how the brain's reward and memory pathways prime inquiring minds for knowledge

Oct 2, 2014 |By Daisy Yuhas

Curiosity motivates us to find out more and helps our brains remember what we discover.
Credit: brian donovan/flickr

Do we live in a holographic universe? How green is your coffee? And could drinking too much water actually kill you?

Before you click those links you might consider how your knowledge-hungry brain is preparing

Phenomenon: Disturbing the State of Equilibrium

Will pressing on the Unifix cubes in the cup disturb the state of equilibrium?

Will we get the same results if the cups are filled with *water* instead?

"a critical competitor"

Can Oil become a cloak of invisibility?

Investigations and Phenomenon-based Learning

Writing Claims with Evidence and Reasons (CER)

Phenomena-based Learning : curiosity leads to thought-provoking questions → students *want to* know

1. ***What*** **just happened? What do I know about it and what do I *not* know?**
2. ***How*** **did that occur?**
3. ***Why*** **did it produce that outcome?**
4. **Under what conditions would it occur again?**

Write Arguments with Evidence

- My **argument** is that ____, because____ .
- My **reasons** are that_____.
- The **evidence** to support my idea is ______
- My **claim** is ____. My evidence is ____ .
- An **argument against that idea** is ______, because_____.
- I would **support that statement,** because _____
- That **reasoning sounds** correct to me, because…
- If someone doubted ____, I would **convince them by**__.

Phenomena-based Learning (cont.): **curiosity leads to thought-provoking questions → *want to* know**

5. ***How* would I *verbally explain* what just happened?**

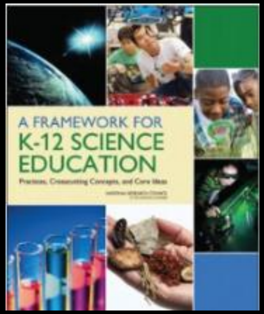
6. **What would someone likely want to see in a *written explanation?***

7. **Where/how can I *find out more* about what happened?**

   - **Phenomena provoke wonder → student learning**

   - **Informational literacy - library, Internet, journals, articles, interview a current/local expert in the field (website → contact them via email)**

   - **Visual literacy - explanatory YouTube videos, demos**



Deep and Long-lasting Learning: Understanding Builds Over Time

What? Information-based (1956 >) *to*

Why does...? Inquiry-based (1996 >) *to*

How? (2012 >) Investigations

(knowledge and skills - practices)

Under what conditions?

What if...?

Academic Language

We **make** observations, **explain** scientific events/phenomena by **describing** those observations in **oral** or **written** forms. We **draw inferences** from our **observations,** as well as from the numerical **data** we collect and **organize.**

Emotions, Attention and the Brain

- Emotions → attention → learning → memory (integrated in the brain)
- It is neurologically impossible to learn and remember information to which the brain has *not* paid attention.

Illocutionary intent - what a speaker *means* to say, although the sentence itself may not be perfectly consistent with the intentions: "The garbage is beginning to smell," which means, "Take that garbage out!" – Close attention to the words does not aid in understanding the intended message.

Academic Language Learning

So that students understand the learning goals, state *explicitly* <u>what</u> the language objective/science content goals are at the beginning of class.

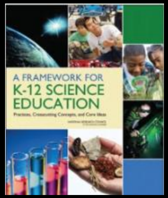
"Today we will engage in an experiment where we will investigate air resistance by constructing *twirly birds* (a.k.a., paper helicopters.)"

- **Who has *seen* a helicopter in flight?**
- **In what directions did that helicopter fly?**
- **What is different about how a helicopter flies and how an airplane flies? ("critical competitor")**

Patterns of Motion: Twirly Bird

CCSS Writing standards K-5:

"Conduct short research projects that build knowledge through investigations of different aspects of a topic."



Deep and Long-lasting Learning

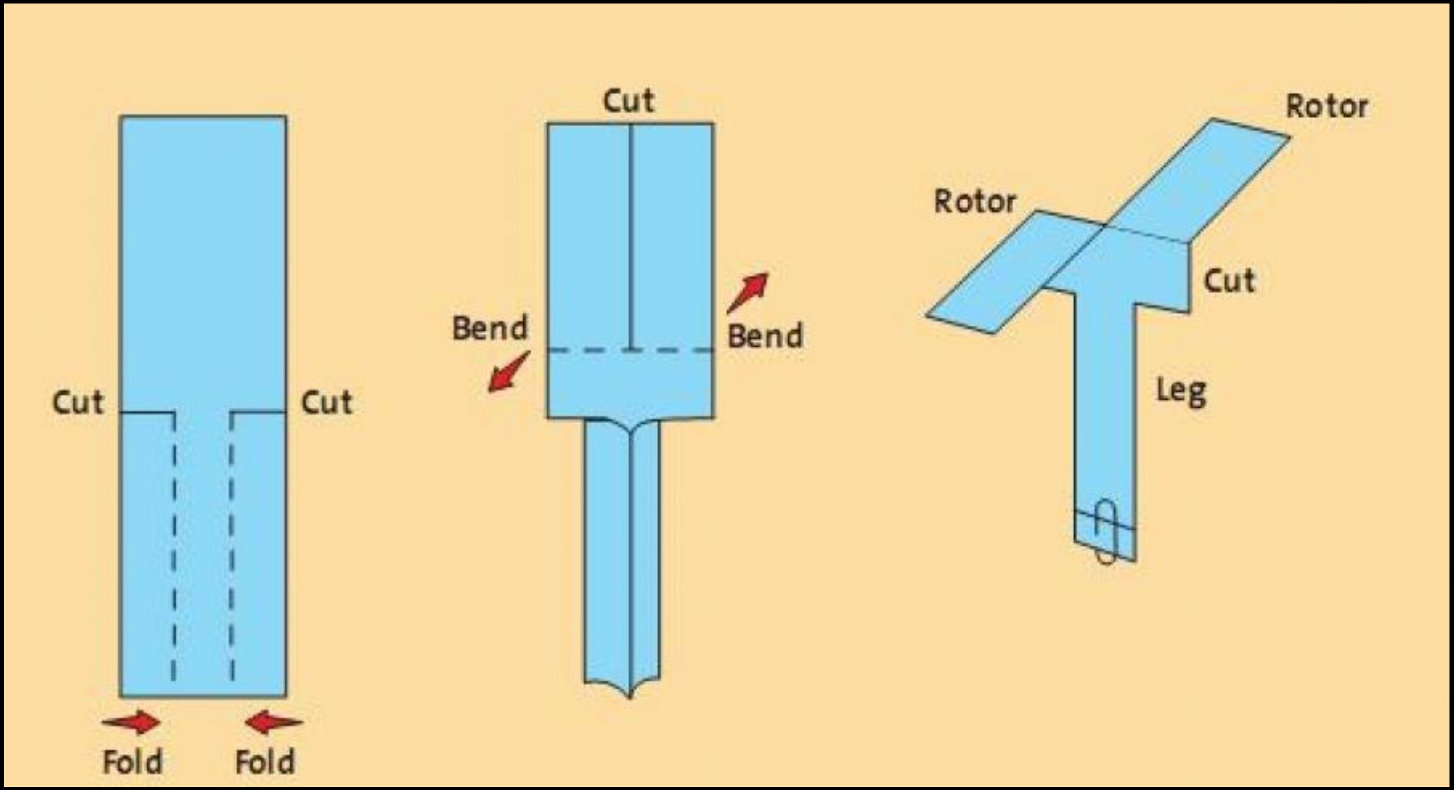
1. **Instructivism =** teacher tells and student listens (the *transmission* of knowledge that gets memorized in isolation).

2. **Constructivism** (Piaget) = the **student learns by "constructing knowledge" -** making connections, inside the body-brain → building/constructing new brain circuitry.

Connected Learning Experiences

3. **Constructionism** (Papert): learning comes by way of **actively constructing knowledge** through the act of **constructing a meaningful product.** Doing/**making** a **tangible and shareable** artifact (public) following a deep **investigation** that unfolds **over multiple days**.

Constructionism (Papert):



Once this object is properly folded, *predict* what will occur when you hold it as high as you can and release it?

Question:

How do you teach vocabulary best?

Answer: In context

Full answer: In *the* context of doing

(not in the context of reading) and

through speaking and writing.

"Predict"

STEM Vocabulary

Instead of saying:	Use MINDFUL LANGUAGE by saying:
"What do you think will happen when…?"	"What do you **PREDICT** will happen when…?"
"Let's look at these two pictures."	"Let's **COMPARE** these two pictures."
"How can you put those into groups?"	"How can you **CLASSIFY**…?"
"Let's work this problem."	"Let's **ANALYZE** this problem."
"What do you think would have happened if…?	"What do you **SPECULATE** would have happened if…?"
"What did you think of this story?"	"What **CONCLUSIONS** can you draw about this story?"
"How can you explain……?"	"What **HYPOTHESES** do you have that might explain...?"
"How do you know that's true?"	"What **EVIDENCE** do you have to support…….?"
"How else could you use this…..?	"How could you **APPLY** this ……..?"

NGSS Highlights #1

Students need to learn ***the language of science*** as a **tool** to both **comprehend,** and **communicate** what they learn/know about science investigations, oral discussion, writing, visual, and their mathematical representations.

Engineering Challenge:
Build a Twirly-bird

- **Creating solutions to *problems* (the work of *engineers* who "engage in a systematic practice of design to achieve solutions particular human problems" -** *NRC, A Framework for K-12 Science Education, 2012, page 11)*
- **Engineers approach** a design problem by looking for a **solution. The success of their solution(s) is determined by how satisfactorily it solves the identified problem *(criteria).***
- **Solutions are *limited* by *constraints* (e.g., the available materials, time, budget/costs, tools, conditions, etc.,) and solutions do not occur via a "light bulb experience." Instead, they require a deliberate, thoughtful, systematic design process.**

Engineering Challenge: Build a Twirly-bird

1. ***Criteria:*** **Can you construct a paper helicopter that can fly for 3 seconds?**

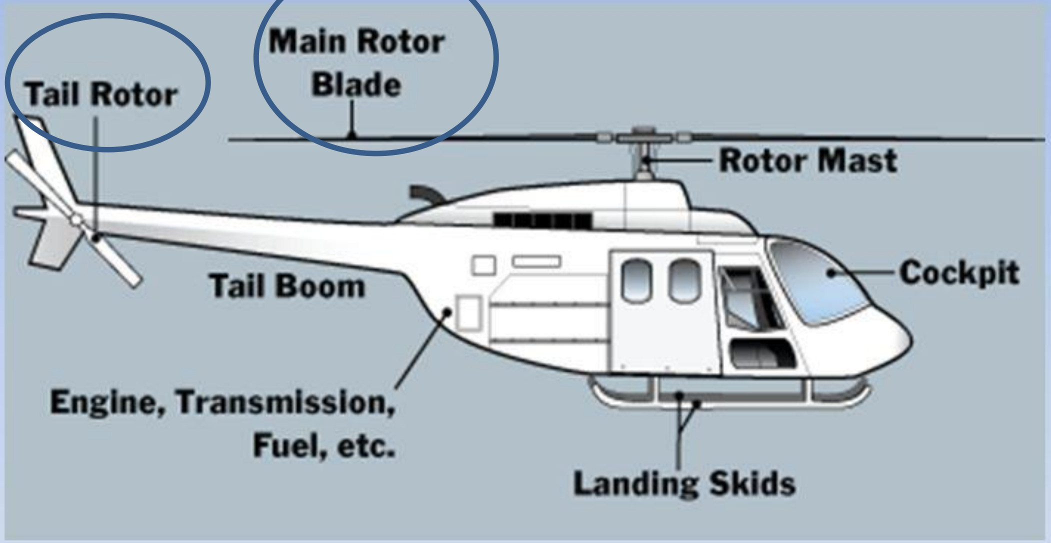
2. ***Constraints:*** **(a) use only the materials provided, (b) you have minutes to construct and test your paper helicopter.**

Use the following items:

- **Paper helicopter cut-out**
- **2 paperclips**
- **Scissors**
- **stopwatch**

Vocabulary in Science: Twirly Bird

Basic Parts of a Helicopter

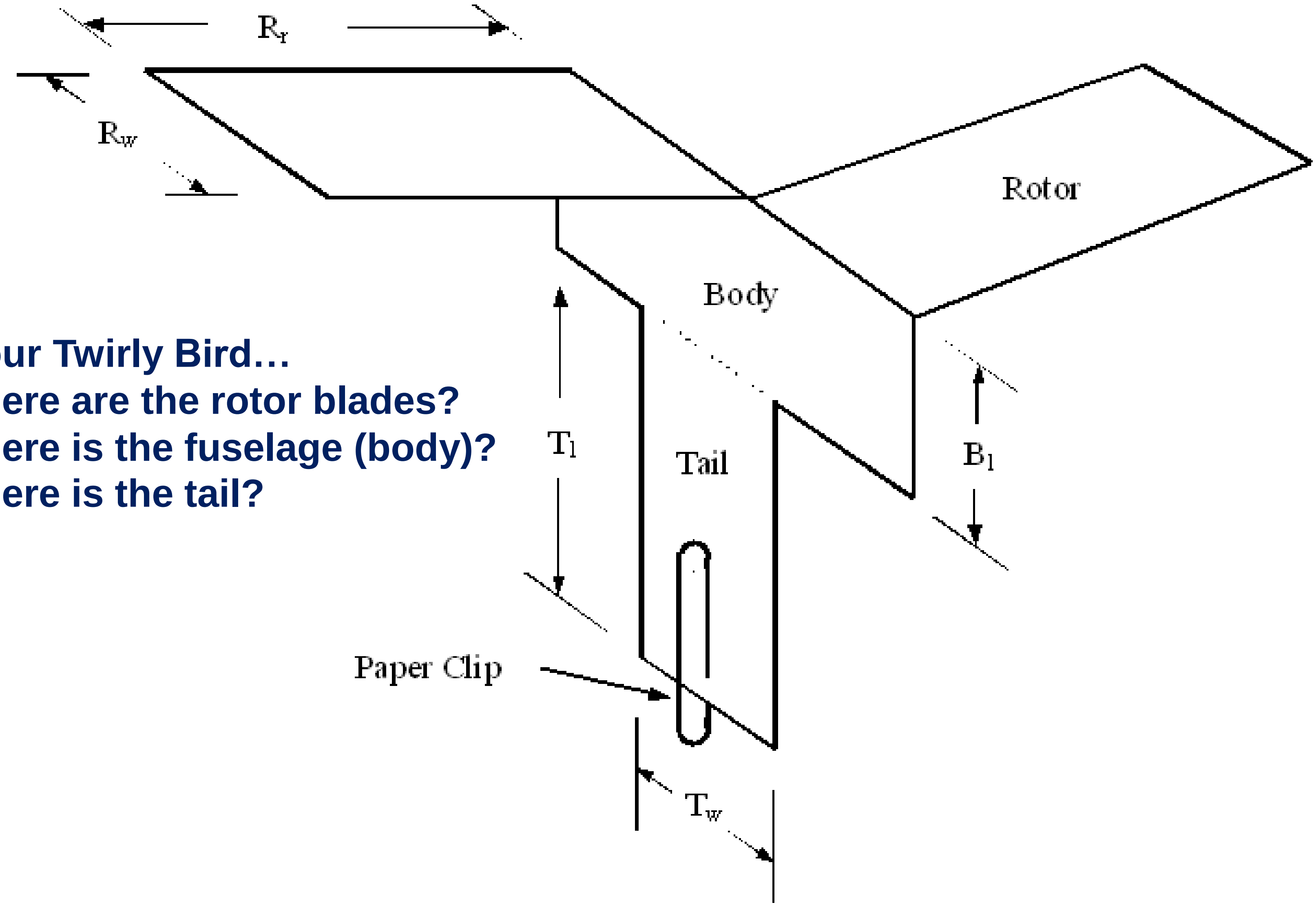


- **Fuselage** -- The main body of the helicopter is known as the fuselage. A frameless plastic canopy surrounds the pilot and connects in the rear to a flush-riveted aluminium frame.

Why are these words important to student discourse?

On your Twirly Bird…

- Where are the rotor blades?
- Where is the fuselage (body)?
- Where is the tail?



Scale, proportion and ratios

Patterns of Motion: Twirly Bird

Observation: STEM practitioners ask questions and *pay attention* (Engineering):

1. In *what direction* did the propellers rotate, clockwise or counter clockwise? (compare the rotor blade patterns the Blue vs. the white helicopters?)

2. What modification could you make to your helicopter that would *cause* the rotor blades to rotate in the *opposite* direction (re-engineering)?

“New and Improved” (vocabulary)

- “The adjacent possible” - advancements and improvements come by way of tinkering with the current technologies (and the resources immediately available) to make gradual changes, not quantum leaps that are several magnitudes “ahead of their time.” Innovative ideas are not conjured out of thin air – they are extensions of the adjacent “existing components”→ into new combinations (“thinkable” extensions on what currently *is*.) Pathways to “the adjacent possible” → Brain-storming dialogues, discourse and conversations (infrequently in schools)

Patterns of Motion: Twirly Bird

3. How would you change the outcome if you added a second paperclip? Compare the systems with a one-variable change:

(a) one paperclip

(b) 2 paperclips

(c) no paperclip (tape).

How did changing this one variable effect outcome?

a. Record your results.
b. Share your group’s findings with the class. (Describe the cause-and-effect relationships you observed?)
c. What forces were at work when the helicopter was in motion?

Patterns of Motion: Twirly Bird

- On a new piece of paper, design a second twirly bird, but make *one* modification to your new system. *(or " ½ class – longer blades; ½ class shorter"* – split-half method)

  a. In your science notebook, describe your modification. What *exact* change (measureable) will you make? How will that change the outcome?

  b. What modification did you make? How did that change produce a new outcome? Compare the prediction.

  c. What did you discover in the process?

  (d. How was the result different for longer vs. shorter rotary blades?)

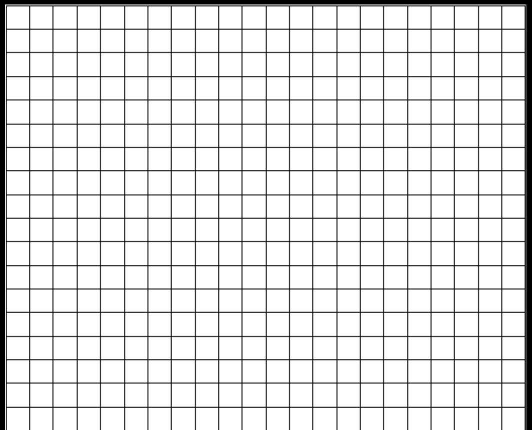
Patterns of Motion: Twirly Bird

After your formal investigation, answer the following question:

- **Where should you place the paperclip on the helicopter to best meet the criteria? Will you get better results if the paperclip is placed vertically or horizontally on the tail?**

Work with a partner,

record your data



In-depth Investigations:
Claims, Evidence and Reasoning
(CCSS and Vocabulary Development)

What are the parts and the important design characteristics on a Twirly Bird that allow it meet the criteria?

The parts of my *Twirly Bird* include the ___________. The _____is important because_________________. Also, the __________ ______helps the system work by __________________.

One problem we encountered was _______________, but we solved it by______________________. However, we could not solve the problem of ________, because ________. In a future re-design, we could possibly________ to correct this problem.

Engineering Challenge: Twirly Bird

4. What are the optimal dimensions of a Twirly Bird?

5. Will a larger Twirly Bird fly longer than a smaller Twirly Bird released at the same distance from the ground? Why? Why not? Explain the reasoning behind your prediction. Investigate your prediction and record your results.

6. If two paperclips are placed on the tail instead of one, how will that modification change the results? Explain the reasoning behind your prediction. Test your prediction and record your results.

Record your data and answer questions in full sentences.

Patterns of Motion: Twirly Bird

7. If you extended the length of the rotary blades 2 inches longer than the standard helicopter, can you predict how that might affect the outcome? If you widened each blade 1 inch, how would that change the motion of the twirly bird? (cause-and-effect)

8. How would you design a helicopter that will descend (drag) faster (with blades still rotating)?

9. What would occur if each blade was a different length?

10. If you had “teardrop-shaped” blades, how might that change the outcome of your flying system? (other shapes?

Patterns of Motion: Twirly Bird

Variables (testable modifications)	Slower	Faster	A more vertical drop	Blades spin faster	Blades spin slower
2 paperclips					
3 paperclips					
4 paperclips					
1 inch wider					
2 inches wider					
1 inch longer					
2 inches longer					
3 inches longer					
4 inches longer					
New shape					
Other?					

1. A standard system
2. Multiple trials (3 times)
3. Share the outcomes

2-PS1-1.

Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS 1-2.

Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Writing standards K-5:

“Conduct short research projects that build knowledge through investigation of different aspects of a topic.”

Patterns of Motion: Twirly Bird

12. What other materials could we use to construct a similarly designed twirly bird that flies?

13. Is there a “maximum size” for a twirly bird? What factors could cause a limitation? (Recruit the custodian and his ladder.)

Summary Science Sentence Stems

1. Our data indicate that …
2. My hypothesis has been proven to be correct/incorrect because…
3. During our observations, we noticed that…
4. Based on our findings, we can conclude that …
5. This is also an example of _________
6. From our additional research from the library/Internet, we found out that…
7. I would suggest an extension activity to investigate…

Patterns of Motion: Twirly Bird

14. Why do scientists only change one variable at a time?

15. How many variations of the original Twirly bird design can you create that will still fly in a similar manner? How many different variables could we change? Is there an optimal size for Twirly birds?

"The 30-Million Word Gap"

- Research shows that vocabulary knowledge is profoundly influenced by SES. By age 4, the average accumulated experience with words for children from…
  - ✓ professional families = approx. 45M words
  - ✓ working-class families = 26M words
  - ✓ welfare families = only 13M words.

(Hart & Risley, 2003)

- Research from Keith Stanovich found that kids who have a solid word base get ahead faster and achieve more in school, while students with a less-developed vocabulary to progress more slowly. K students in lowest 25%le for vocabulary development are 3 grades behind by Gr. 6.

- State of AZ

Developing Early Literacy through Active Learning

- Students most often learn new words through rich conversations (“serve-and-receive” not by listening).
- Students with sparse language experiences including ELLs, need to *actively* engage in academic discussions with peers and adults on a regular basis
- UCB’s Center for Research in Education, Diversity, and Excellence — CREDE): to make connections, learn new concepts, and learn the appropriate words to describe those concepts, students need to have an abundance of “instructional conversations” - academic discussions. Interactive discussions about new words and attention-grabbing high-utility vocabulary helps students expand their vocabulary “schemas” (Beck & McKeown).

Academic Language in Science a Context

Introduce/reinforce vocabulary in an *active context*.
(“Constructive expression” not phonics → vocab. dev.)

1. Helicopter
2. Experiment
3. Observe
4. Compare
5. Propeller
6. Gravity
7. Rotate
8. Rotary blade
9. Descend
10. Drag
11. Model
12. Engineering
13. Affect
14. Motion
15. Friction
16. Standard
17. Predict
18. Modify
19. Re-engineering
20. Observation
21. Outcome
22. Extend
23. Stationary
24. Variable
25. Controlled variable
26. Manipulated variable
27. Increase/decrease
28. Clockwise/counter…
29. Gravitational pull
30. Mass
31. Forces
32. Interaction
33. Cause-and-effect
34. Modification
35. Length
36. Widen
37. Design
38. Materials
39. Investigate
40. Twirl
41. Spin
42. Findings
43. Shaft
44. Resistance
45. Variation
46. Vertical
47. Optimal
48. System
49. Trials
50. Practices

Vocabulary Development

4,000 – 8,000 words when entering elementary school

40,000 avg. when they exit high school

36,000 word difference

For 13 school grades (K-12) = 2,769 words/year

178 days for 2,769 = 16 words/school day

4K- 8,000 words when entering elementary school

87,000 exposed to/should have mastered upon exiting HS

79,000 word difference

For 13 school grades (K-12) = 6,076 words/year

178 days for 6,076 = 34 words/school day

How We Learn/Understand Vocabulary: Connecting Words with Meaning

- **Words are used to think. The more words we know, the finer our understanding of the world.**

  -- Stahl, 1999

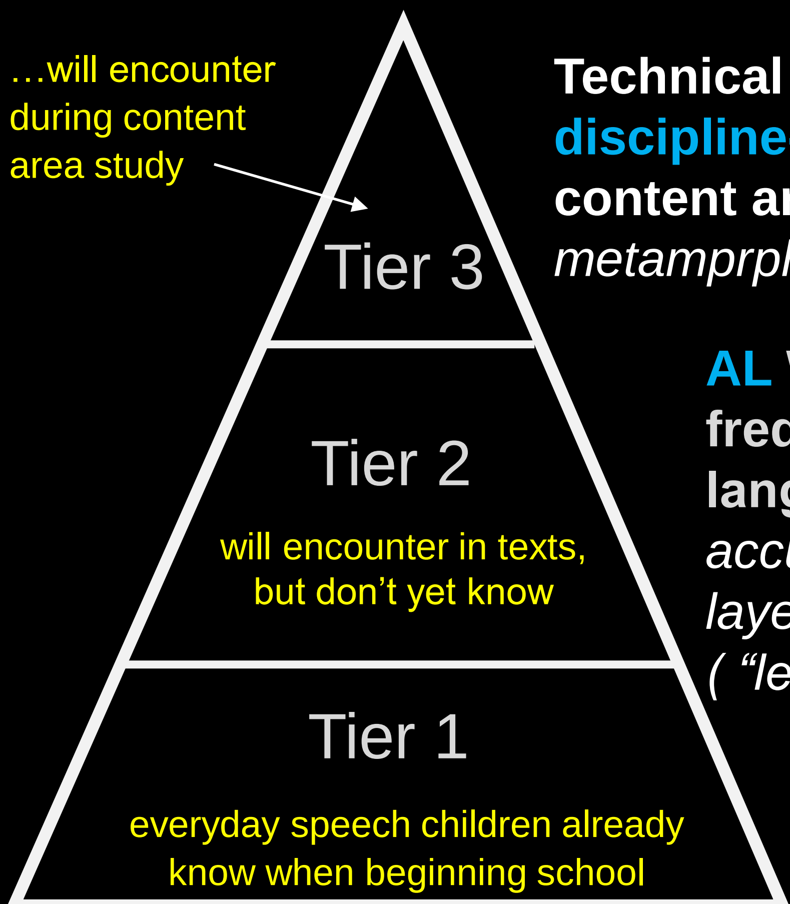
- **Language is recorded thought.**

Semantic dementia: a neurodegenerative disorder → lose touch with the meaning of words. When they lose the word for a specific emotion, the patient can no longer recognize that emotion in other people.

Words are also used to process in-coming information, to understand and evaluate other's ideas, and to understand still *other* words.

Three-Tier Model for Vocabulary

CCSS, Appendix A
Originally Developed by Isabel Beck



Technical terms, seen/used with ↓ frequency, rare, discipline-specific words, not generalizable; limited to content area, AL: *lava, monarchy, allegory, agonist, metamprphic, amendment, respiration, acute, molecule*

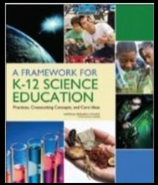
AL Words to teach: general academic, ↑ frequency, ↑ utility across disciplines/written lang., ↓ use in spoken lang.: *vary, innovation, accumulate, cite, formulate, predict. surface, layer, evaluate, structure, adjust, function, bicker ("lethargic" rather than "tired")*

Known, basic, common, conversational/ oral vocabulary, concrete words: *clock, baby, run, book, see, tree, back, sad, animal (80% of text)*

Developing Early Literacy through Active Learning

All children, and particularly children from language-impoverished backgrounds, benefit most from learning environments that are:

- **Experience-rich**
- **language-rich ("serve and receive" verbal interactions -- primary caregiver feedback)**
- **print-rich (classrooms with word walls, writing samples, books of every genre, real-world objects, etc., and homes where parents/siblings *model* that *reading and dialogue* have tremendous power and value)**



3-Dimensions of Learning Science

NEXT GENERATION SCIENCE STANDARDS

Eight Practices

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing Explanations and Designing Solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Seven Crosscutting Concepts

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change

Four Disciplinary Core Ideas:

- ✓ Life Science,
- ✓ Physical Science
- ✓ Earth and Space Science
- ✓ Engineering, Technology and Applications of Science

The best way to predict your future is to invent it.

– Alan Kay

How do we know that a classroom has embraced and implemented the STEAM recommendations?

- ***What is the teacher doing differently?***
- ***What are the students doing differently?***

STEAM – STREAM Recommendations

“What formal education for one child for one year depends on what his/her teacher *believes, knows, and does* – and *doesn't believe, doesn't know,* *and doesn’t do".*

All professional progress will take place *outside of* your comfort zone.

"Reflect and Connect"

"We don't learn from experience, we learn by *reflecting* on it."

-- John Dewey

- **What was the most valuable idea(s) that *you learned* this afternoon?**
- **Write down two "I will…" statements. (How will you use this new information or knowledge?)**