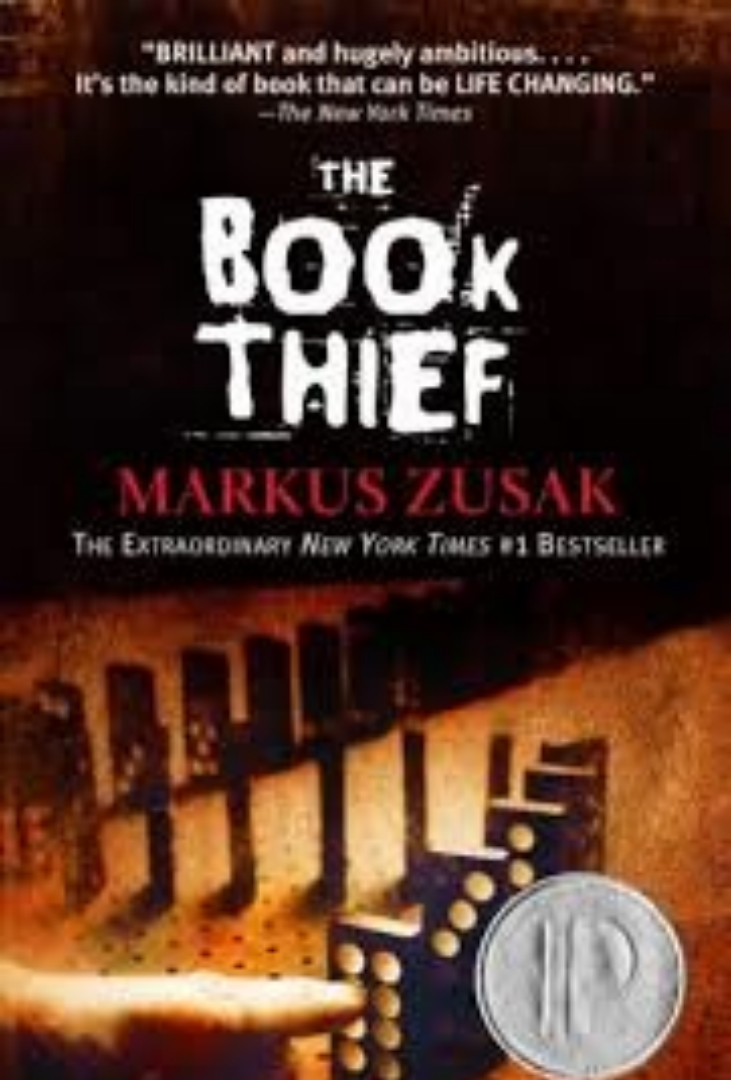
MIDDLE TENNESSEE STATE UNIVERSITY

Inference Generation and Knowledge Acquisition: Key Factors in Reading Comprehension

Amy M. Elleman, Ph.D.

AIM INSTITUTE



—Of course, an introduction.

A beginning.

Where are my manners?

I could introduce myself properly, but it's not really necessary. You will know me well enough and soon enough, depending on a diverse range of variables. It suffices to say that at some point in time, I will be standing over you, as genially as possible. Your soul will be in my arms. A color will be perched on my shoulder. I will carry you gently away.

At that moment, you will be lying there (I rarely find people standing up). You will be caked in your own body. There might be a discovery; a scream will dribble down the air. The only sound I'll hear after that will be my own breathing, and the sound of the smell, of my footsteps.

The question is, what color will everything be at that moment when I come for you? What will the sky be saying?

Personally, I like a chocolate-colored sky. Dark, dark chocolate. People say it suits me. I do, however, try to enjoy every color I see—the whole spectrum. A billion or so flavors, none of them quite the same, and a sky to slowly suck on. It takes the edge off the stress. It helps me relax.

Why do students struggle with comprehension?

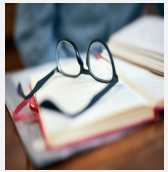
- **Decoding & word recognition**
- **Language** (e.g., syntax, morphology, semantics)
- **Executive function** (e.g., comprehension monitoring, self-regulation, attention, working memory)
- **Reasoning** (e.g., pattern recognition, analogical skills)
- **Inference**
- **Vocabulary**
- **Knowledge**
- **Motivation**
- **Print exposure**

A little bit about me…

Today we will explore…

Current Issues in Comprehension

Key Factors: Knowledge & Inference

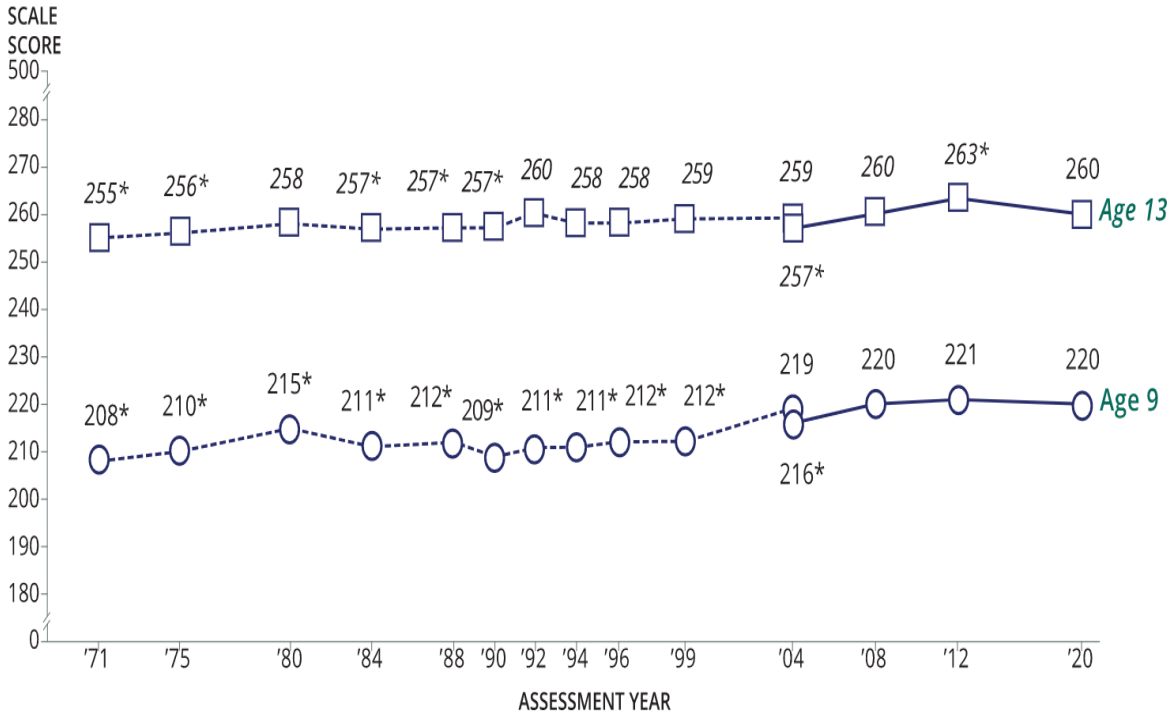


Teaching Tips: Strategies and Resources

Current Issues in Comprehension

FIGURE | Trend in NAEP long-term trend reading average scores for 9- and 13-year-old students

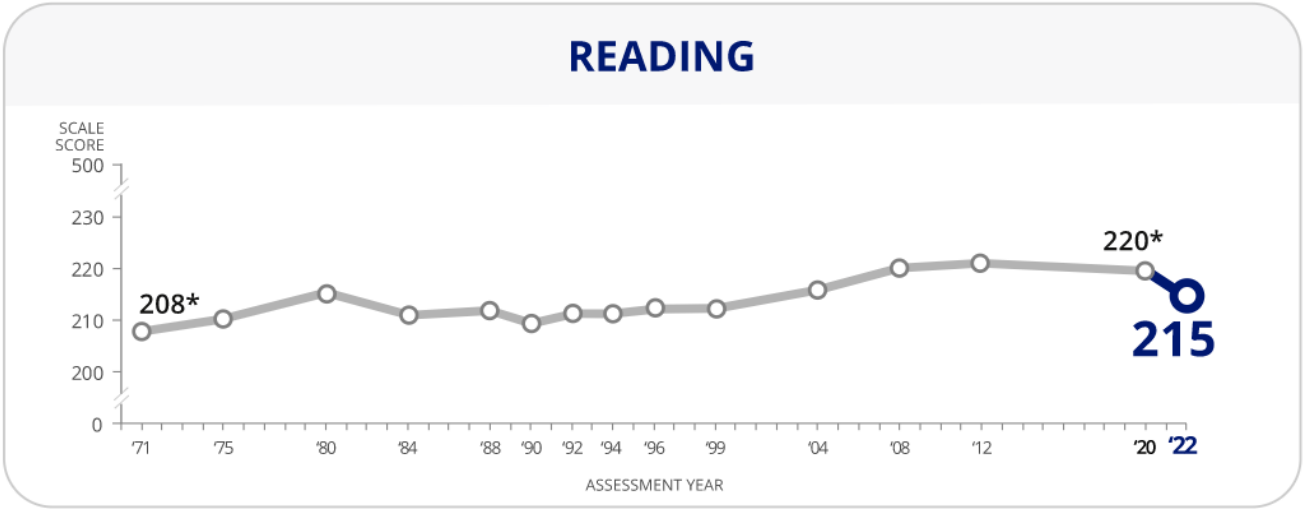
DISPLAY AS **GRAPH** TABLE



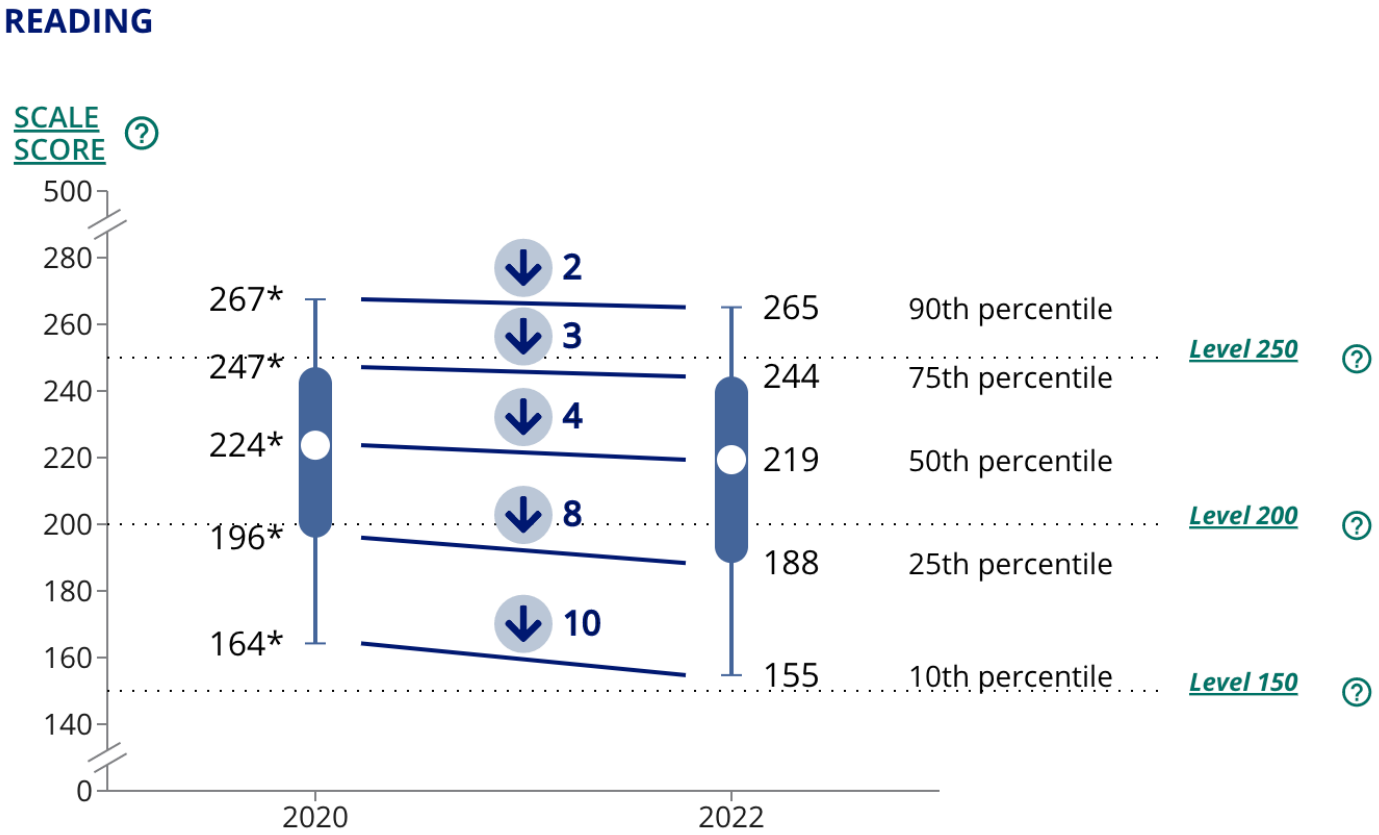
LEGEND

- Original assessment format
- Revised assessment format
- * Significantly different ($p < .05$) from 2020.

NAEP Reading Trend - Grade 4



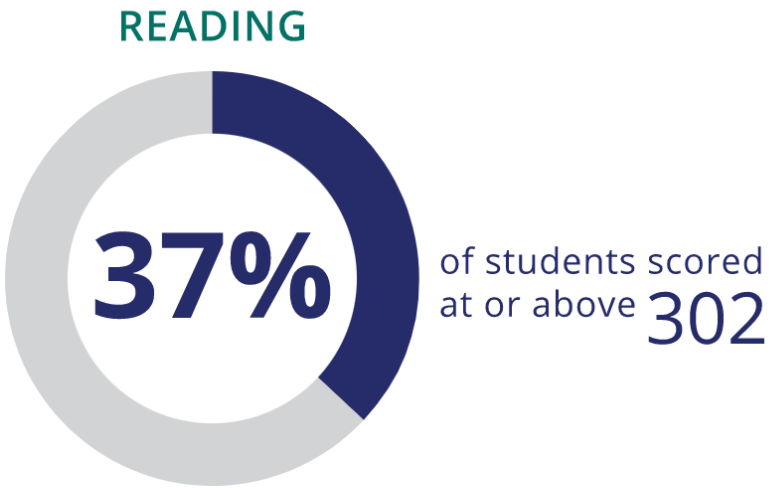
NAEP Reading Differences 2020-2022 – Grade 4



50% Ready for College-Level Text

ACT (2006)

FIGURE | Provisional estimate of the percentage of students academically prepared for college: 2019



Programme for International Student Assessment (PISA; 2015)

Source: Huffington Post

PISA (2018)

		Mean score in PISA 2018			Long-term trend: Average rate of change in performance, per three-year-period			(P
		Reading Mean	Mathematics Mean	Science Mean	Reading Score dif.	Mathematics Score dif.	Science Score dif.	Readi Score
OECD	**OECD average**	487	489	489	0	-1	-2	-3
	Estonia	523	523	530	**6**	**2**	0	4
	Canada	520	512	518	-2	**-4**	**-3**	-7
	Finland	520	507	522	**-5**	**-9**	**-11**	-6
	Ireland	518	500	496	0	0	**-3**	-3
	Korea	514	526	519	**-3**	**-4**	**-3**	-3
	Poland	512	516	511	**5**	**5**	2	6
	Sweden	506	502	499	**-3**	-2	-1	6
	New Zealand	506	494	508	**-4**	**-7**	**-6**	-4
	United States	505	478	502	0	-1	2	8
	United Kingdom	504	502	505	2	1	-2	6

Why?

- Complexity of reading comprehension- mismatched instruction and assessment
- Some aspects of comprehension instruction have been emphasized to the detriment of other important factors
- Research to practice gap
    - 100 years of reading comprehension research, yet very little has made it into teachers' hands

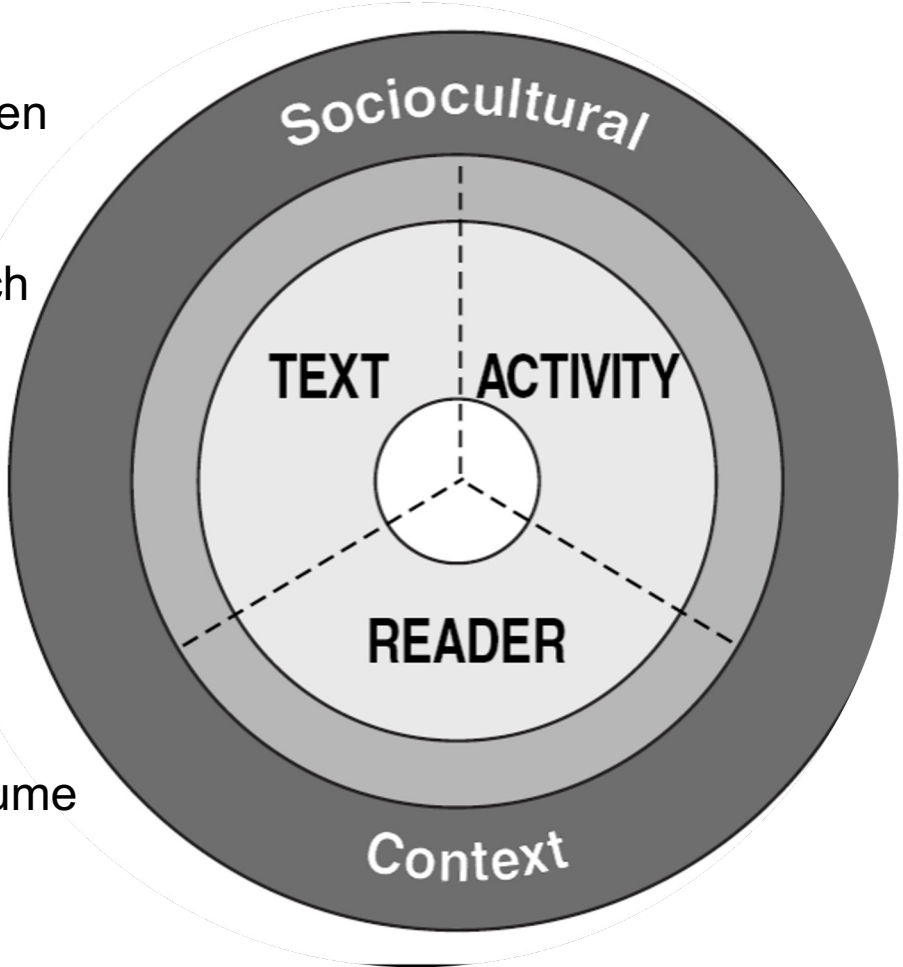
Reading Comprehension is…

“the process of simultaneously extracting and construction meaning through interaction and involvement with written language.” - Rand Reading Study Group’s Report (Snow, 2002)

RAND Reading Study Group Report (2002)

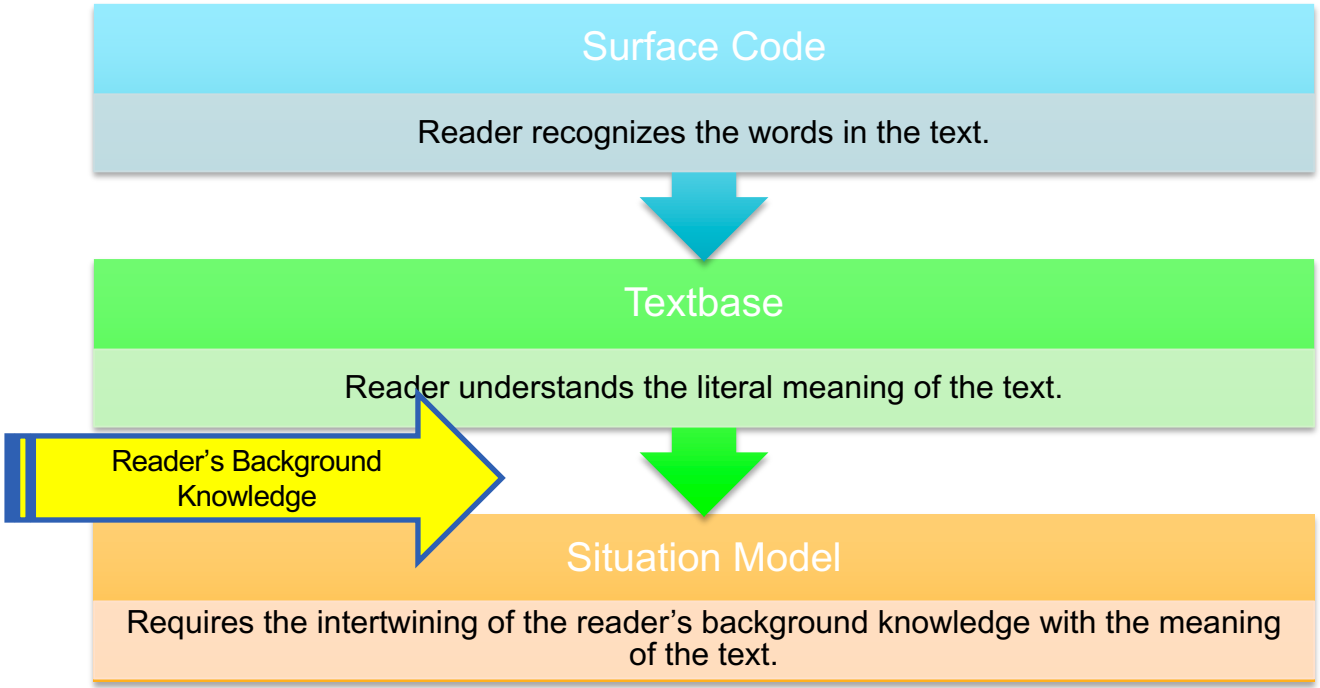
- Mismatch between reader and text
- Text are chosen arbitrarily to teach isolated skills

- Lower reading ability
- Low reading volume



- Instruction that consists of testing, not teaching comprehension
- Tasks aren't aligned with comprehension goals

The Complex Process of Understanding Text: Construction-Integration Model (Kintsch, 1998)

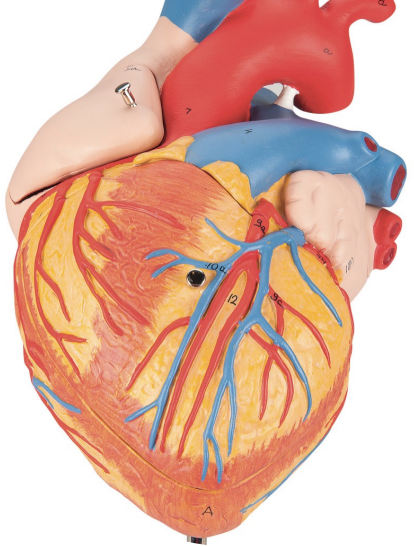


Knowledge Acquisition

Studies of Expertise

(Ericsson, 2016)

- People who have deeper knowledge in a domain perform better than people who are “smarter” or “better” in initial aptitude.
- This has been shown across multiple fields of experts (e.g., chess) and studies of the influence of expertise on reading ability (e.g., baseball, heart function, Vietnam War).



Benefits of Knowledge

- New knowledge is dependent on the integration of prior knowledge (e.g., McNamara, et al., 2007)
- Well-connected memory stores allow quicker retrieval of information needed to generate inferences (e.g., Ericcson & Kintsch, 1995; Kendeou & O'Brien, 2014)
- Even limited knowledge about a topic improves comprehension (Bransford & Johnson, 1972)

Knowledge Account of Reading Comprehension

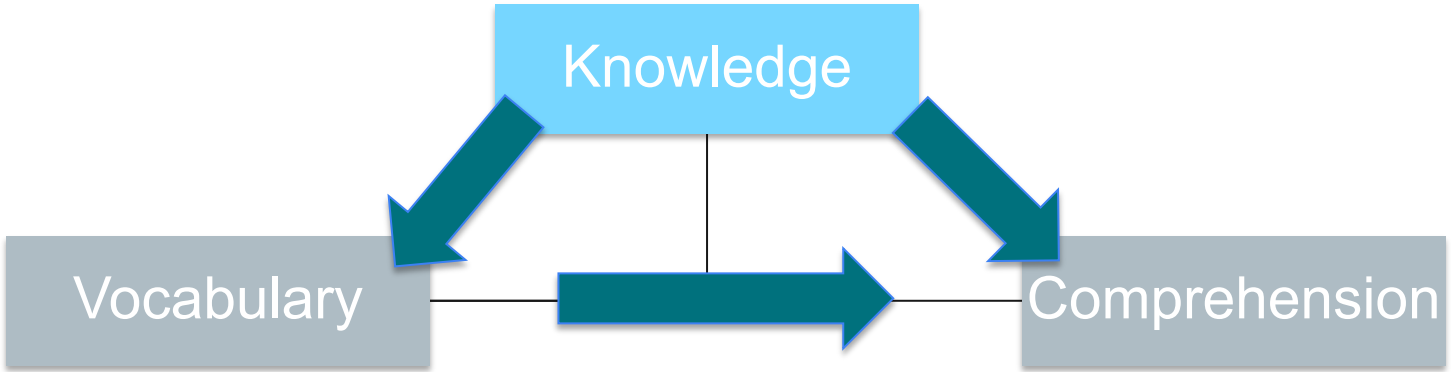
(Ericsson & Kintsch, 1995; Kendeou et al., 2014)

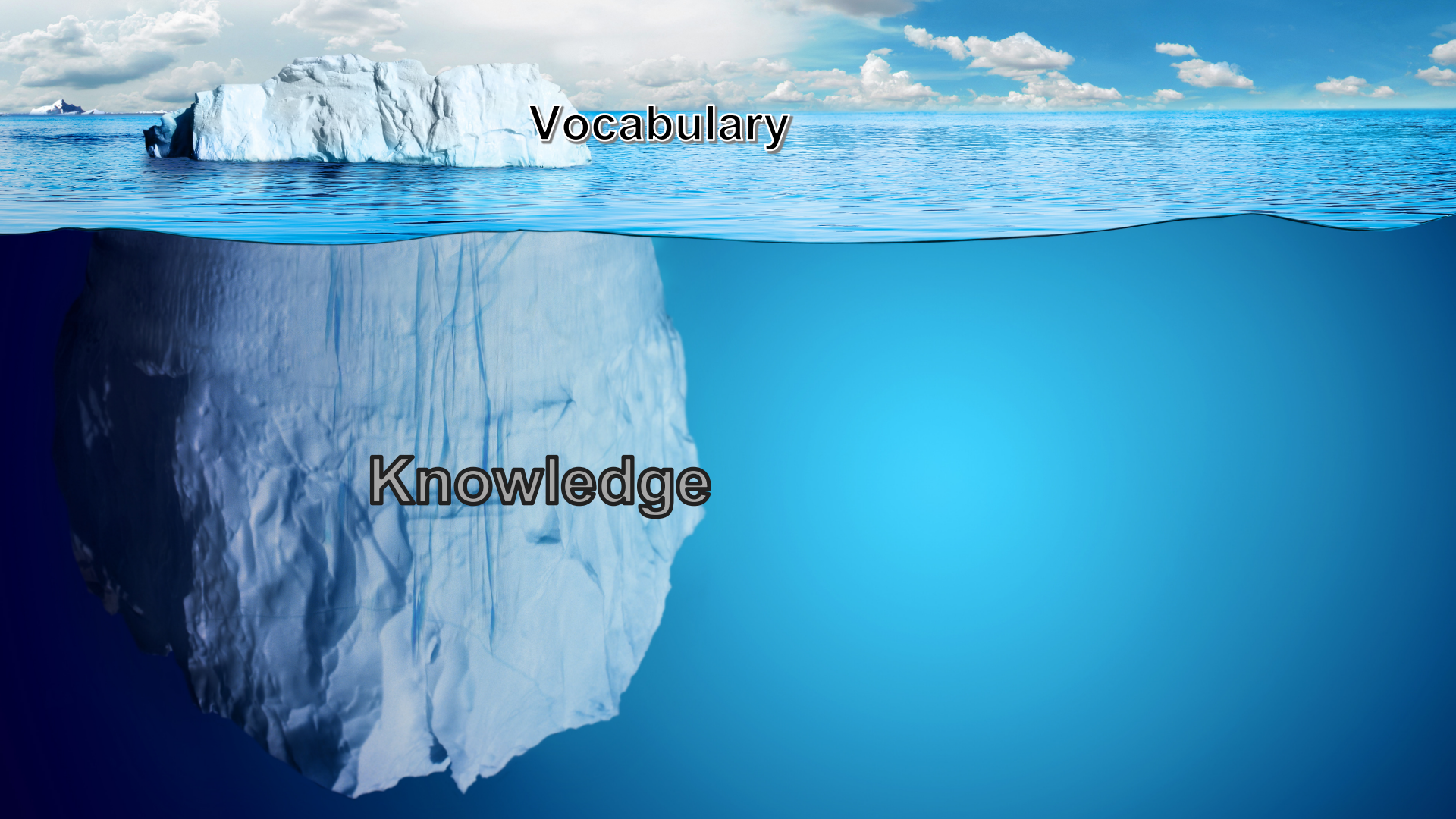
- Knowledge is considered to drive comprehension skill rather than other capacities (e.g., reading ability, working memory).

- Shown to be an important predictor of reading comprehension (e.g., Kulesz et al., 2016; Ahmed et al., 2016; Wang et al., 2021)

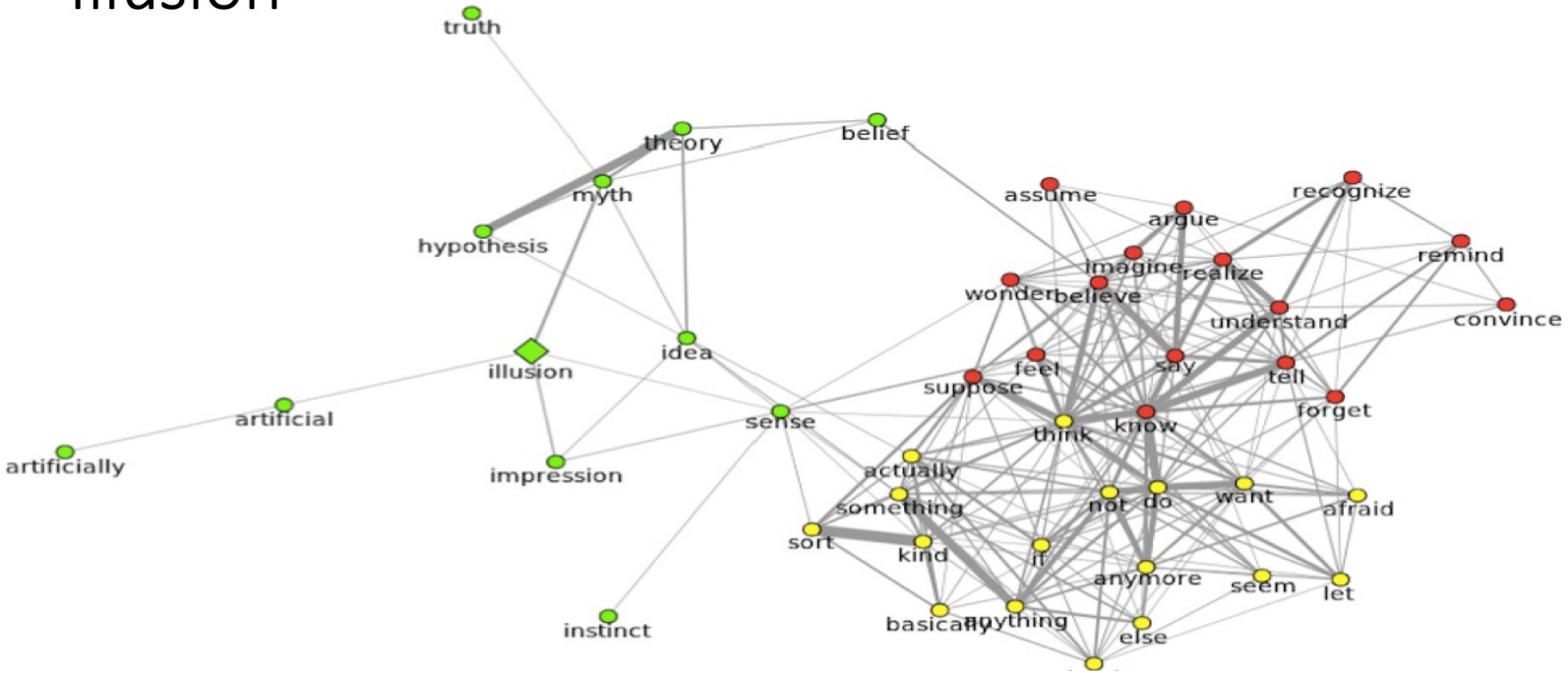
- Readers who possess more knowledge exhibit better comprehension and knowledge retention than those with lower levels of knowledge (Kendeou & van den Broek, 2005)

Why Such a Strong Relationship between Vocabulary and Comprehension ?




Vocabulary
Knowledge

“Illusion”


truth
theory
belief
myth
hypothesis
assume
recognize
argue
remind
imagine
realize
wonder
believe
understand
convince
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illusion
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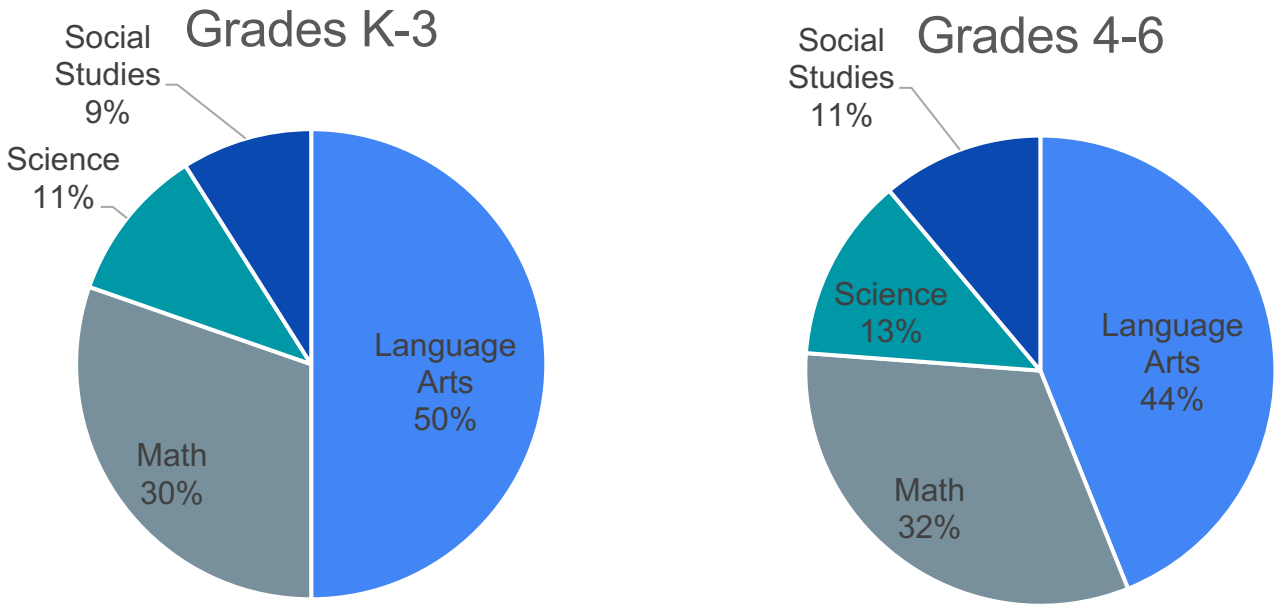
anything
else

Knowledge Development in Elementary Classes



Baniflower et al. (2013) Report of National Survey of Science and Mathematics Education

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Exploring the role of knowledge in predicting reading and listening comprehension in fifth grade students☆

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Transfer

ABSTRACT

Various knowledge sources have been hypothesized to relate to individual differences in reading comprehension skill in developing readers. We present results from two studies using explanatory item-response models to examine the unique role of knowledge in predicting reading and listening comprehension in 5th grade students (mean age of 10.77 years). In study 1, we investigated the importance of different knowledge sources for comprehending grade-level passages. Participants were 254 students with a range of reading abilities. We found that passage-specific topic familiarity, general academic knowledge, and vocabulary knowledge were all significantly associated with the probability of correctly answering questions about a passage. In study 2, we

Study 1

- 5th grade students (*n* = 254) participated in a study to consider the relative importance of factors related to comprehension
- Examined the factors related to increasing the probability of correctly answering open-ended questions about a passage
  - Knowledge factors
    - Passage specific topic knowledge
    - General academic knowledge
    - Vocabulary knowledge
  - Reading factors
    - General reading comprehension
    - Word reading accuracy
    - Passage fluency
  - Cognitive factors
    - Working memory

Results

Knowledge factors were more important than word reading, fluency, general comprehension, and working memory.

Table 4

Complete model representing unique variance in item responses on the qri comprehension questions explained by child, question, and passage features.

Parameter	Est.	SE	z	p
Fixed				
Intercept ($\widehat{B}_0$)	0.02	0.43	0.05	0.957
Child-by-passage variable				
Passage-specific topic familiarity ($\widehat{B}_1$)	0.50	0.11	4.61	0.001*
Child characteristics				
General reading comprehension ($\widehat{B}_2$)	0.02	0.02	0.97	0.331
Isolated word reading accuracy ($\widehat{B}_3$)	−0.00	0.01	−0.55	0.580
Passage reading fluency ($\widehat{B}_4$)	−0.00	0.00	−1.93	0.054
Working memory ($\widehat{B}_5$)	0.01	0.01	0.51	0.613
Vocabulary ($\widehat{B}_6$)	0.02	0.00	5.58	0.001*
Academic knowledge ($\widehat{B}_7$)	0.10	0.02	4.84	0.001*
Question feature				
Literal ($\widehat{B}_8$)	1.20	0.46	2.59	0.010*
Passage feature				
Listen ($\widehat{B}_9$)	−1.60	0.47	−3.42	0.001*
Random				
Intercept (child)	0.28			
Topic familiarity (child)	0.12			
Cov(intercept, familiarity; child)	−0.08			
Intercept (question)	1.54			
General knowledge (question)	0.00			
Cov(intercept, general knowledge)	0.04			
Intercept (passage)	0.00			

Note. Estimates are on the logit scale. Cov = covariance.
*p < .05.

Study 2

- 5th grade students with learning disabilities (*n* = 26) at AIM Academy taking a year long interactive humanities course focused on the Italian Renaissance.

AIM Academy Mission

- AIM Academy's mission is to provide extraordinary educational opportunities to children with language-based learning disabilities such as dyslexia and specific comprehension difficulties utilizing research-based intervention strategies and an arts-based learning environment that is college preparatory in scope and sequence.

Interactive Humanities Scope & Sequence

- Grade 1, Origins, students take on the roles of paleontologists and archaeologists to examine fossil records to see what they reveal about the origins and evolution of life on Earth.
- Grade 2, River Valley, students are transported to the time of the earliest human settlements which demonstrate the transition from cave life to permanent settlements.
- Grade 3, Ancient Egypt, Greece and Rome, students take on roles of the legendary gods and goddesses of each culture which captures their imagination and sparks their enthusiasm.
- Grade 4, Middle Ages, the students travel back in time to explore the fall of the Roman Empire through medieval times.
- **Grade 5, Italian Renaissance, students join together as members of an artisan's guild in 16th century Florence. Under the tutelage of their patron, students discover the accomplishments of each luminary in the guild and examine how each individual contributed to this exciting era of rebirth and enlightenment.**

Fifth Grade Humanities: Renaissance

5th Grade Interactive Humanities
Italian Renaissance

Fifth grade Interactive Humanities students transform into great thinkers of the Italian Renaissance, joining together as members of an artisan's guild in 16th century Florence. Over the course of the school year, the guild's patron, Isabella d'Este, guides students through 300 years of history. Each character is given a turn in the spotlight, helping students to discover the accomplishments of each luminary in the guild and examine how each individual contributed to this exciting era of rebirth and enlightenment.

The members of the AIM Renaissance Guild are…

Dante Alighieri, poet and writer of *The Divine Comedy*. Students learn about the history of bookmaking and the invention of the printing press, and create their own codex with a marbled cover and handsewn binding.

Giotto di Bondone, the painter known as "The Father of the Renaissance". While studying Giotto's rise to fame, students learn the art of fresco painting, a painting created directly on wet plaster.

Lorenzo Ghiberti, goldsmith and sculptor of the magnificent bronze Gates of Paradise. The guild creates its own version of these baptistery doors featuring "bronze" panels hand-tooled in the metal repousse' technique.

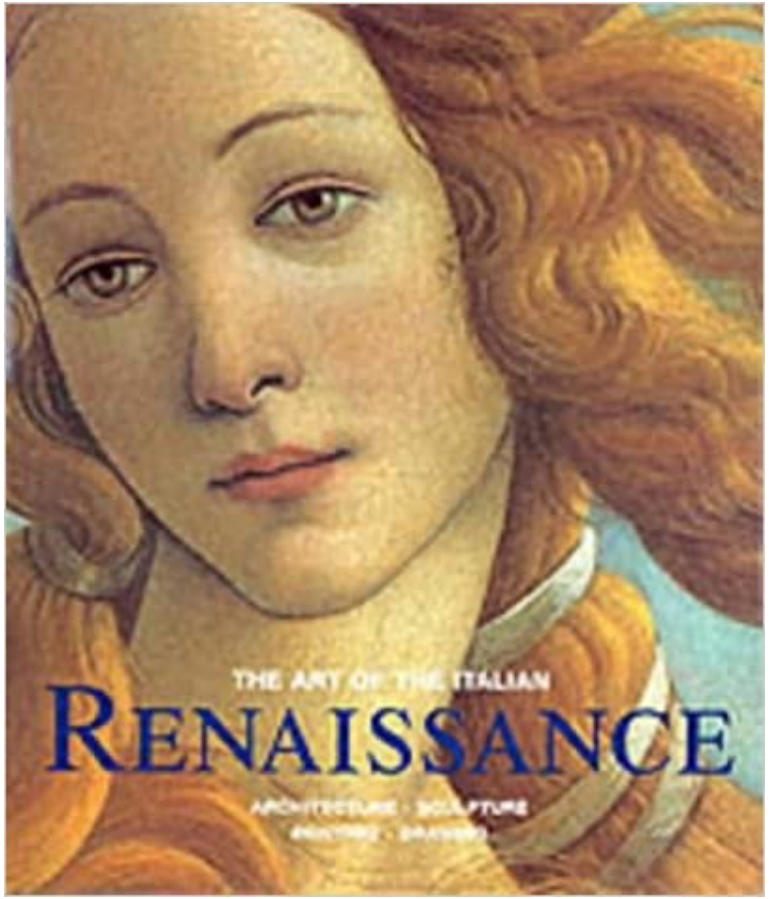
Filippo Brunelleschi, brilliant architect and designer of the Duomo, the domed roof of the Florence Cathedral. Students study the mathematical principles that Brunelleschi applied to his innovations in linear perspective drawing, and discover the hallmarks of Renaissance era architecture.

Sandro Botticelli, the painter known for his mythological scenes, and **Raphael Sanzio**, master painter of the High Renaissance. Together, Botticelli and Raphael introduce the guild to the art of the portrait and its ties to humanist philosophy, and help students draw connections between the Renaissance (literally, "rebirth") and the Classical Period of ancient Greece and Rome.

Leonardo Da Vinci, the true "Renaissance Man" who excelled as an artist, scientist, writer, inventor, and mathematician, among other pursuits. Through his famed *Mona Lisa*, Da Vinci takes students further into their study of portraiture, culminating in an acrylic self portrait rendered on canvas.

Galileo Galilei, scientist and astronomer, helps the guild learn about the dueling theories of geocentrism and heliocentrism during the late Renaissance. Students also study lunar cycles, and participate in a dramatic reenactment of Galileo's trial and subsequent imprisonment.

Donatello, creator of the first major piece of Renaissance free-standing figure sculpture, and **Michelangelo Buonarroti**, sculptor of the David and painter of the Sistine Chapel. Interactive Humanities completes the school year with an examination of bronze and marble sculpture through the Renaissance, trying our hand at the reductive technique favored by Michelangelo. For their final commission, the guild works collaboratively to create a permanent work of art for the classroom, a ceiling panel inspired by the beautiful Sistine Chapel.



Study Purpose

- Interested in how deep knowledge might affect transfer of knowledge from a familiar topic to an unfamiliar topic
- Students listened to 2 passages
  - Topic-familiar passage, Guttenberg's Printing Press, about how the printing press led to the democratization of knowledge
  - Passage on an unfamiliar topic about the use of Twitter during the Arab Spring crisis
- Asked open-ended analogous questions such as
  - Why was the printing press an important discovery?
  - Why was Twitter an important invention?

Knowledge, Reading, and Cognitive Factors

- We also wanted to know what knowledge, reading, and cognitive factors might impact students' ability to transfer their knowledge from one passage to the other
  - Language processing and syntax (CELF Recalling Sentences)
  - Verbal analogical reasoning (WJ-III)
  - Nonverbal reasoning (Raven's Matrices)
  - Listening comprehension (WJ-III)

Results

Table 5
Fixed effects and variance explained in item responses for Twitter passage comprehension questions explained by printing press question, question type, and child characteristics for both aligned and randomized printing press questions.

Parameter	Aligned printing press questions				Aligned printing press questions, question type, and child characteristics				Randomized printing press questions, question type, and child characteristics			
	Est.	SE	*z*	*p*	Est.	SE	*z*	*p*	Est.	SE	*z*	p
Fixed												
Intercept ($\widehat{B}_0$)	−0.37	0.35	−1.03	0.305	−0.03	0.43	0.07	0.994	0.75	0.47	1.58	0.112
Child-by-question variable												
Aligned printing press question ($\widehat{B}_1$)	0.80	0.30	2.68	0.007*	0.65	0.30	2.15	0.031*				
Random printing press question ($\widehat{B}_1$)									−0.49	0.30	1.65	0.099
Question type												
Global vs. Literal ($\widehat{B}_2$)					−0.94	0.63	1.46	0.137	−1.09	0.68	1.58	0.113
Global vs. Local ($\widehat{B}_3$)					0.09	0.64	0.14	0.883	−0.21	0.67	0.31	0.759
Global vs. Text to IH ($\widehat{B}_4$)					−0.42	0.63	0.66	0.506	−0.78	0.68	1.15	0.249
Child characteristics												
Nonverbal reasoning ($\widehat{B}_5$)					0.10	0.01	5.16	0.001*	0.10	0.01	5.61	0.001*
Listening comprehension ($\widehat{B}_6$)					−0.12	0.05	2.21	0.027*	−0.09	0.05	1.68	0.092
Verbal analogies ($\widehat{B}_7$)					0.11	0.11	0.99	0.321	0.12	0.11	1.07	0.283
Sentence repetition ($\widehat{B}_8$)					0.04	0.01	2.89	0.004*	0.04	0.01	3.12	0.002*

Random	Variance (Conditional/ unconditional)	Percent explained	Variance (conditional/ unconditional)	Percent explained	Variance (conditional/ unconditional)	Percent explained
Child	0.933/1.010	7.60 %	0.131/1.010	87.0 %	0.118/1.010	88.0 %
Question	0.706/0.839	15.85 %	0.543/0.839	35.0 %	0.638/0.839	24.0 %

Note. IH = Interactive Humanities.
*p < .05.

Study 2 Findings

- Despite past research showing that most people (including adults) do not transfer knowledge from one area to another easily (Gick & Holyoak, 1980; Bransford & Schwartz, 1999), we found evidence that the students in this study may be leveraging their extensive background knowledge to understand a new unfamiliar topic.
- Language processing and nonverbal reasoning were also important factors in students' ability to transfer their knowledge.

Knowledge is important, but studies have shown…

- Skilled readers use knowledge more actively and efficiently than less skilled readers (McNamara et al., 2007)
- Struggling readers have been shown to have less developed background knowledge *and* be passive when reading (Cain et al., 2001)
- When background knowledge is controlled, poor comprehenders still have difficulty making inferences (Barnes et al., 1996)

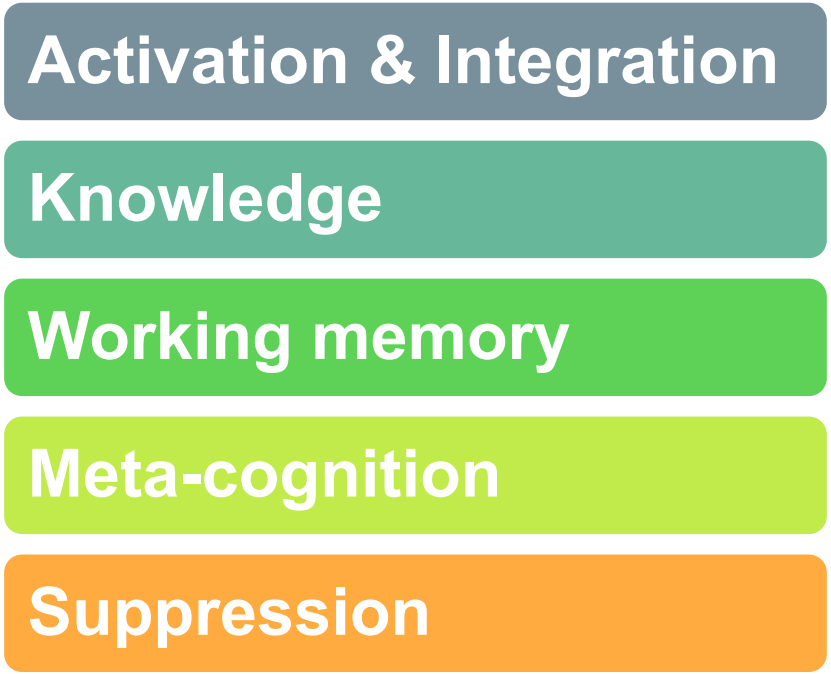
So, knowledge is only part of the answer …

Inference Generation

Importance of Inference

- Understanding an implied message is essential in any act of communication
- Researchers across many disciplines consider inference a central component in language and reading comprehension
- Texts are rarely fully explicit
- Inference ability has been shown to predict current and later comprehension skills

Driving Factors in Inference Generation



Types of Inferences

Local Inferences

- Referents to pronouns and synonyms
- Meanings of unknown vocabulary

Global Inferences

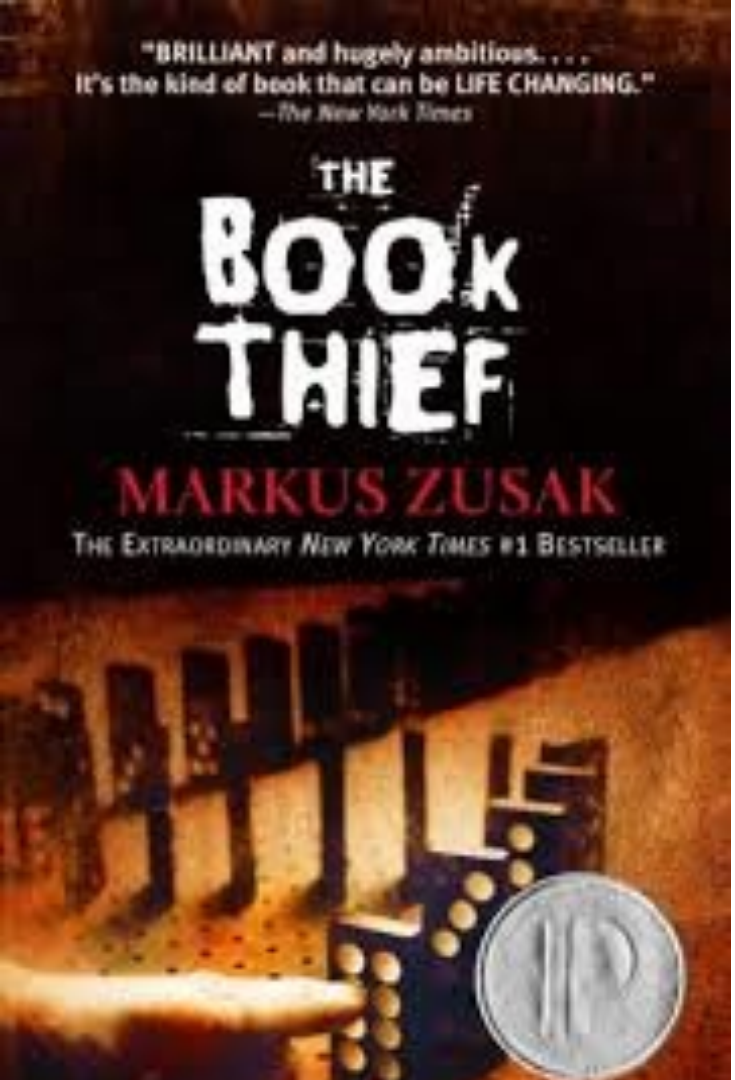
- Character feelings and motives
- Elaborations
- Themes
- Cause and effect
- Author’s purpose/intent

Poor Comprehenders

Peter lent his coat to Sue because she was cold.

Who was very cold, Peter or Sue?

-Yuill & Oakhill (1991)



—Of course, an introduction.

A beginning.

Where are my manners?

I could introduce myself properly, but it's not really necessary. You will know me well enough and soon enough, depending on a diverse range of variables. It suffices to say that at some point in time, I will be standing over you, as genially as possible. Your soul will be in my arms. A color will be perched on my shoulder. I will carry you gently away.

At that moment, you will be lying there (I rarely find people standing up). You will be caked in your own body. There might be a discovery; a scream will dribble down the air. The only sound I'll hear after that will be my own breathing, and the sound of the smell, of my footsteps.

The question is, what color will everything be at that moment when I come for you? What will the sky be saying?

Personally, I like a chocolate-colored sky. Dark, dark chocolate. People say it suits me. I do, however, try to enjoy every color I see—the whole spectrum. A billion or so flavors, none of them quite the same, and a sky to slowly suck on. It takes the edge off the stress. It helps me relax.

Dancing with Effect Sizes

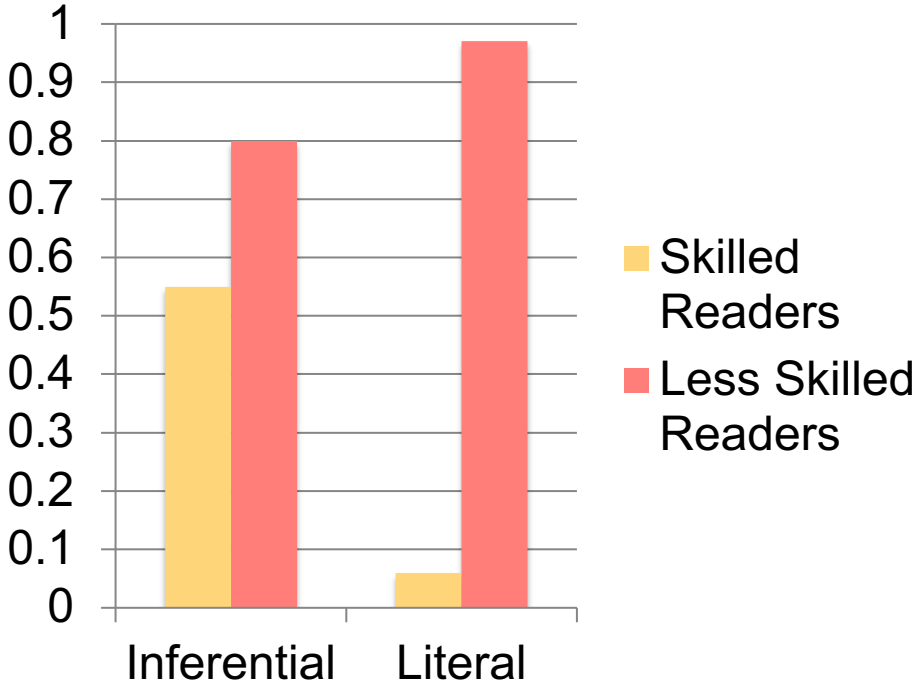
Large
d = .80

Moderate
d = .50

Small
d = .20

Efficacy of Inference Interventions in Grades 2-9 (Elleman, 2017)

Comprehension Measure	Overall ES
General (k = 13)	+0.58
Inferential (k = 25)	+0.68
Literal (k = 18)	+0.28



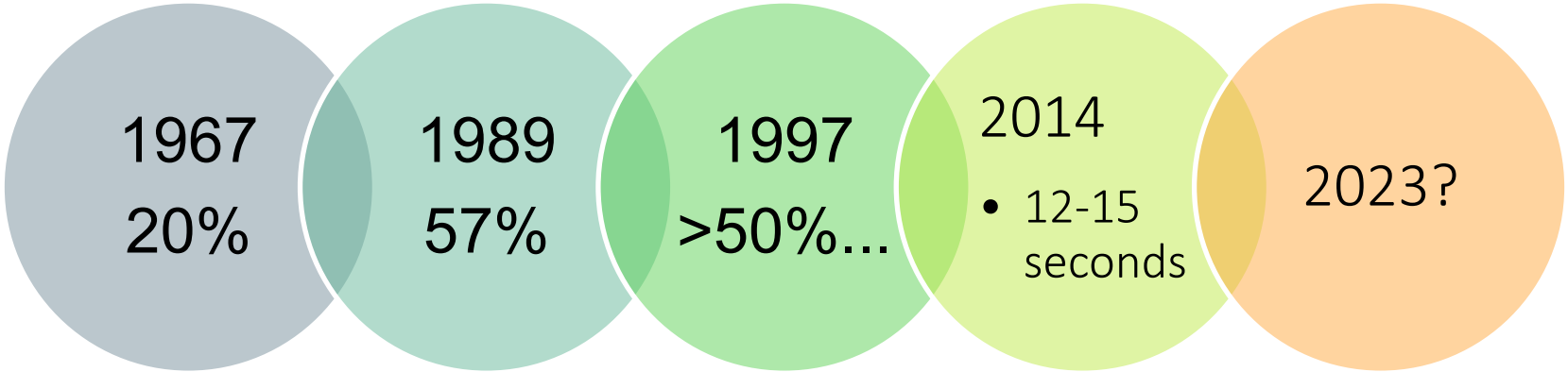
Effective Inference Strategies

- **Inference Questions**
  - Practice (Sundbye, 1987)
  - Learning how to answer inference questions (Stitt, 1968)
  - Answering elaborative causal questions at important junctures in the text (Carnine et al.,1982; Siefert, 1993)
- **Text Clues**
  - Using keywords, self-questioning, & answer confirmation (Holmes, 1985)
  - Text clues, question generation, & predictions (Yuill & Oakhill, 1988)
  - Learning inference types and using context clues for key vocabulary (Reutzel & Hollingsworth, 1988)

Effective Inference Strategies

- **Activating and using prior knowledge**
  - Awareness of the need to use background knowledge and activation of prior knowledge (Hansen & Pearson, 1983; Hansen, 1980)
  - Integrating prior knowledge with new knowledge, text organization, and practice answering questions (Carr, 1982)
- **Character Perspective**
  - Motives (Carnine et al., 1982)
  - Inferring feelings and actions (Emery & Milhalevich, 1992)

Classroom Inference Instruction

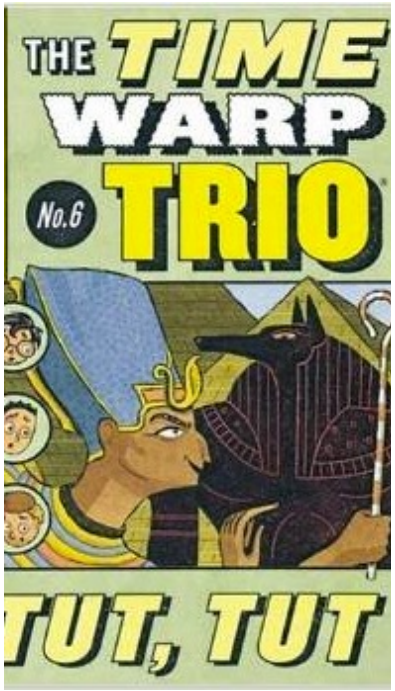


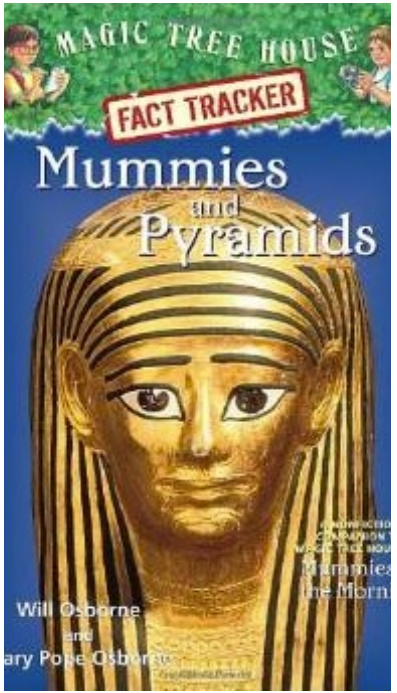
Inference and Knowledge Instruction Study 1

Inference and Knowledge Instruction for 5th Grade Students

Study Purpose

- Considering the most effective strategies found in the meta-analysis, we developed a multi-component inference intervention.
- Reading Detectives (Inference) vs. Reading Explorers (Knowledge)





Participants - 5th grade students (*n* = 94)

Demographic	n (%)
Female	56 (60%)
IEP	5 (5.3%)
Tier 2 (Read 180)	5 (5.3%)
Ethnicity	
White	81 (86.2%)
African-American	3 (3.19%)
Hispanic	7 (7.45%)
Other	3 (3.19%)

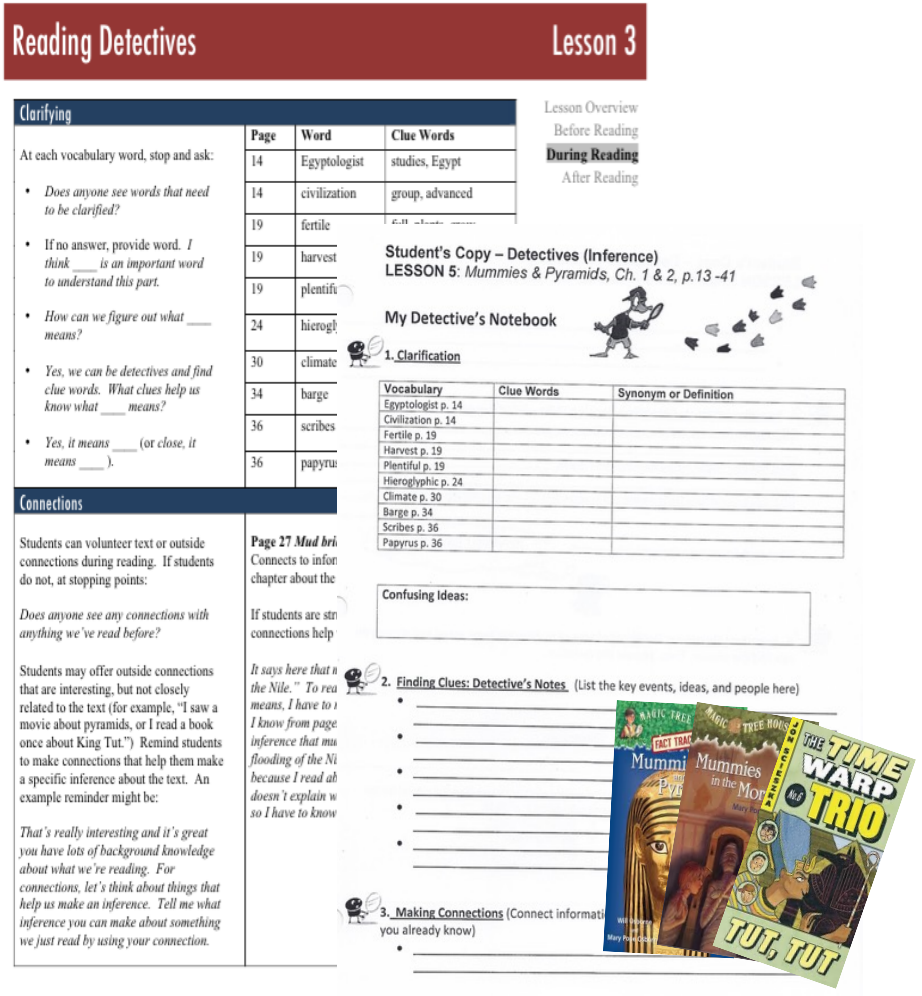
Procedures & Texts

- Students were individually randomly assigned to 3 conditions (i.e., inference – reading detectives, knowledge – reading explorers, or BAU).
- Trained doctoral students provided 10 - 1 hour sessions of instruction to groups of 8-10 students over two weeks.
- Students read short passages and two texts about Ancient Egypt.

	Ancient Egypt Text	Lexile
Introduction (L.1-2)	Short passages	---
Practice (L. 3-6)	Mummies and Pyramids, Mary Pope Osborne	650
Practice (L. 7-10)	Tut! Tut! Time Warp Trio Jon Sczieska	700

Inference Condition: Reading Detectives

- Clarify vocabulary using clue words[1]
- Find clues about characters[1] and events[1,2]
- Make connections within and outside of the text[1,2]
- Provide evidence[1,2]
  - What's important and why is it important?
  - How do you know?
- Practice answering inferential questions[1,2]



Strategies taught with: [1]Narrative, [2]Expository

Motives and Clues

(Beers & Probst, 2013; Carnine et al. 1982; Emery & Milhalevich, 1992)

Character Motives & Text Clues

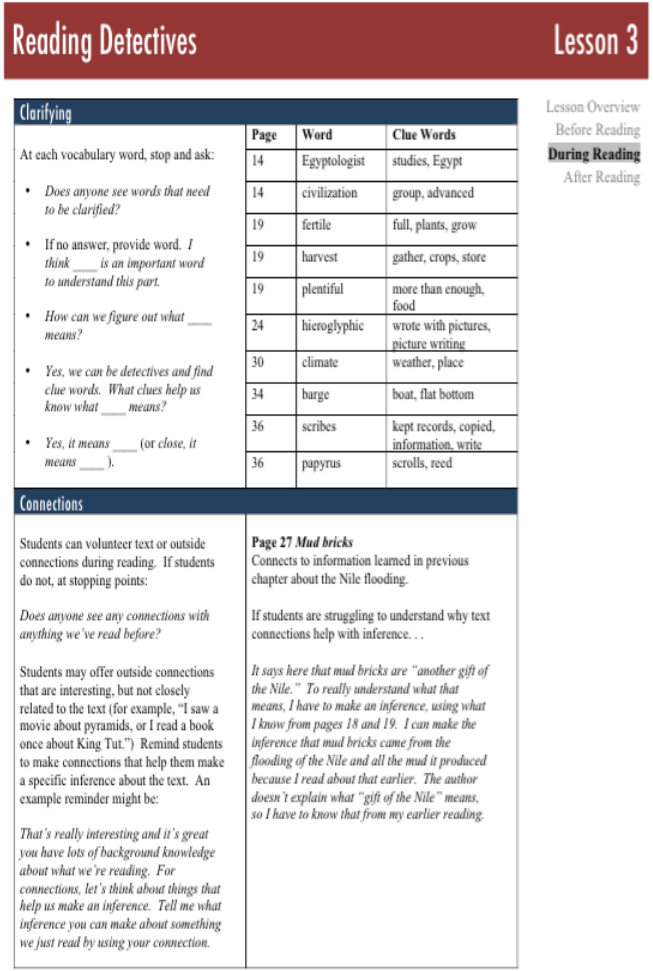
- Introduced by discussing how a detective might think someone was suspect
- Make connection between “reading” people and knowing characters really well
- Should always stop and note when a character is acting in a way that is unexpected

Author Motives & Text Clues

- Should closely consider three clues
  - Repeated information
  - Lengthy description
  - Anything unexpected that happens

Relevant Connections

- Refocusing prompt
  - Does the information that you just told us help us in understanding the story (or answering the question) better?



Reading Detectives **Lesson 3**

Lesson Overview
Before Reading
During Reading
After Reading

Clarifying

At each vocabulary word, stop and ask:

- *Does anyone see words that need to be clarified?*
- If no answer, provide word. *I think ___ is an important word to understand this part.*
- *How can we figure out what ___ means?*
- *Yes, we can be detectives and find clue words. What clues help us know what ___ means?*
- *Yes, it means ___* (or *close, it means ___*).

Page	Word	Clue Words
14	Egyptologist	studies, Egypt
14	civilization	group, advanced
19	fertile	full, plants, grow
19	harvest	gather, crops, store
19	plentiful	more than enough, food
24	hieroglyphic	wrote with pictures, picture writing
30	climate	weather, place
34	barge	boat, flat bottom
36	scribes	kept records, copied, information, write
36	papyrus	scrolls, reed

Connections

Students can volunteer text or outside connections during reading. If students do not, at stopping points:

Does anyone see any connections with anything we've read before?

Students may offer outside connections that are interesting, but not closely related to the text (for example, "I saw a movie about pyramids, or I read a book once about King Tut.") Remind students to make connections that help them make a specific inference about the text. An example reminder might be:

That's really interesting and it's great you have lots of background knowledge about what we're reading. For connections, let's think about things that help us make an inference. Tell me what inference you can make about something we just read by using your connection.

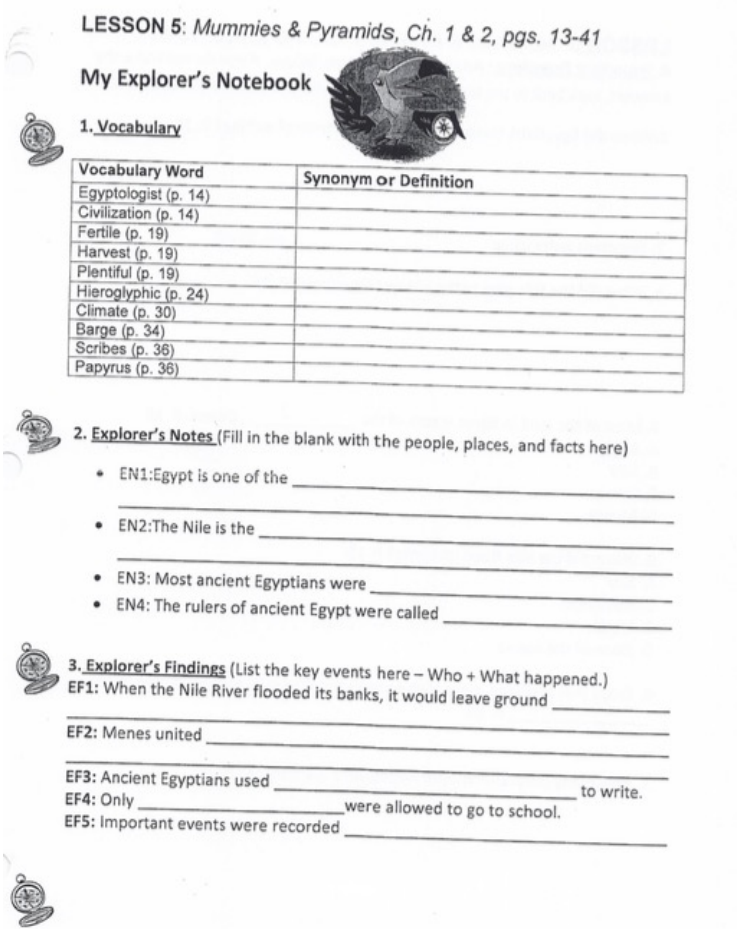
Page 27 *Mud bricks*
Connects to information learned in previous chapter about the Nile flooding.

If students are struggling to understand why text connections help with inference. . .

It says here that mud bricks are "another gift of the Nile." To really understand what that means, I have to make an inference, using what I know from pages 18 and 19. I can make the inference that mud bricks came from the flooding of the Nile and all the mud it produced because I read about that earlier. The author doesn't explain what "gift of the Nile" means, so I have to know that from my earlier reading.

Knowledge Condition: Reading Explorers

- Look for information
  - Text structure - use headers, pictures, & bolded words
- Take detailed notes
- Carefully read and answer questions
- Reread when necessary



LESSON 5: *Mummies & Pyramids, Ch. 1 & 2, pgs. 13-41*

My Explorer's Notebook

1. Vocabulary

Vocabulary Word	Synonym or Definition
Egyptologist (p. 14)	
Civilization (p. 14)	
Fertile (p. 19)	
Harvest (p. 19)	
Plentiful (p. 19)	
Hieroglyphic (p. 24)	
Climate (p. 30)	
Barge (p. 34)	
Scribes (p. 36)	
Papyrus (p. 36)	

2. Explorer's Notes (Fill in the blank with the people, places, and facts here)

- EN1:Egypt is one of the _____
- EN2:The Nile is the _____
- EN3: Most ancient Egyptians were _____
- EN4: The rulers of ancient Egypt were called _____

3. Explorer's Findings (List the key events here – Who + What happened.)

EF1: When the Nile River flooded its banks, it would leave ground _____

EF2: Menes united _____

EF3: Ancient Egyptians used _____ to write.

EF4: Only _____ were allowed to go to school.

EF5: Important events were recorded _____

Daily Lesson for Inference and Knowledge Conditions

	Min.	Reading Detectives	Reading Explorers
Warm-up	5	Read short passages & answered inferential questions	Read short passages & answered literal questions
Vocabulary	10	Context clues (when appropriate)	Provided with a synonym or short definition
Read with Strategies or Focus on Content	30	Inference	Content
Identify and Answer Questions	15	Inferential	Literal

Results

Treatment vs. Control	*p*	*ES* *g*
Content Knowledge	*<.001*	**2.31**
Comprehension in Learned Domain	.001	**.46**
Inference	.001	**.30**
Literal	.010	**.30**
Gates-MacGinitie	.289	-.07
QRI Total	.847	.09

Inference vs. Knowledge	*p*	*ES* *g*
Content Knowledge	.091	-.39
Comprehension in Learned Domain	.179	-.11
Inference	.146	-.20
Literal	.417	-.03
Gates-MacGinitie	.790	.12
QRI Total	.517	.04

Possible Explanations

- The inference strategies were not effective for increasing comprehension.
- Findings could also be interpreted within the knowledge account of reading comprehension (e.g., Kendeou & O'Brien,2014).
  - With enough high-quality information to draw upon, inferences would be generated effortlessly, and the strategies would not be useful.
- Typical readers don't require these types of strategies – at least for texts at or below their grade level.

Evaluating the Impact of a Multistrategy Inference Intervention for Middle-Grade Struggling Readers

Amy E. Barth[a] and Amy Elleman[b]

Purpose: We examined the effectiveness of a multistrategy inference intervention designed to increase inference making and reading comprehension for middle-grade struggling readers.
Method: A total of 66 middle-grade struggling readers were randomized to treatment (n = 33) and comparison (n = 33) conditions. Students in the treatment group received explicit instruction in 4 inference strategies (i.e., clarification using text clues; activating and using prior knowledge; understanding character perspectives and author's purpose; answering inferential questions). In addition, narrative and informational texts were carefully chosen and sequenced to build requisite background knowledge to form inferences. Intervention was delivered in small groups of 3 students for 10 days of instruction.
Results: One-way analysis of covariance models on outcome measures with the respective pretest scores as a covariate revealed significant gains on a proximal measure of Egyptian-content knowledge (g = 1.37) and on a standardized measure of reading comprehension—i.e., Wechsler Individual Achievement Test–Third Edition Reading Comprehension (g = 0.46).
Conclusion: The moderate effect on a standardized measure of reading comprehension provides preliminary evidence for the effectiveness of this multistrategy inference intervention in improving reading comprehension of middle-grade struggling readers.

Changes to Intervention, Procedures, and Measures

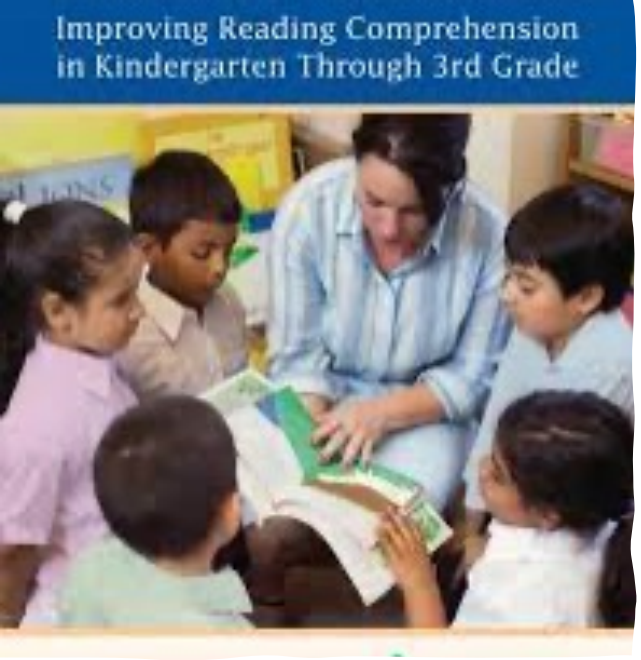
- Participants were less skilled readers in grades 6-8
- Only had two groups – inference and BAU
- Added more difficult, short expository passages about Egypt.
- Provided the correction procedure for irrelevant information at the beginning.
- Replaced the Gates with the WIAT.
- Treatment was offered in small groups of 2-3.

Warm-up	**5 minutes**
Vocabulary	**10 minutes**
Read with Strategies	**20 minutes**
Identify and Answer Questions	**10 minutes**

Results

		Treatment	Business as Usual
WIAT_SS	*N*	32	29
	adj *M*	88.86	85.09
	SD	.99	1.04
	Hedge's *g* (*SE*)		0.46
	F(1,58) =		6.88
	p =		.0111
ECKA	*N*	32	29
	adj *M*	12.95	8.21
	SD	.63	.61
	Hedge's *g* (*SE*)		1.37
	F(1,58) =		26.73
	p =		<.0001
QRI-Comp	*N*	32	29
	adj *M*	12.73	10.65
	SD	.66	.70
	Hedge's *g* (*SE*)		0.36
	F(1,58) =		4.68
	p =		.0346
QRI-Retell	*N*	32	29
	adj *M*	11.35	10.82
	SD	1.14	1.20
	Hedge's *g* (*SE*)		-0.01
	F(3,62) =		.10
	p =		.7543

Note. WIAT-SS is the Wechsler Individual Achievement Test, Reading Comprehension Standard Score. ECKA is the Egyptian Content Knowledge Assessment, Raw Score. QRI-Comp is the Qualitative Reading Inventory Total Score for the Comprehension questions, Raw Score. QRI-Retell is the Qualitative Reading Inventory Retell Total Score, Raw Score.



Strategy Instruction vs. Knowledge Development

- Strong evidence for teaching strategies – especially for students who have reading difficulties
- Filderman et al. (2021)
  - Comprehension instruction for struggling readers in grades 3-12 (ES = 0.59)
  - Higher effects for studies that focused on knowledge development with an additional instructional component (e.g., strategy instruction)
- Hwang et al. (2022) – Integrated literacy and content
  - Effects for vocabulary (ES = 0.91), comprehension (0.40), & content knowledge (ES = 0.89)

Strategy Instruction – Considerations

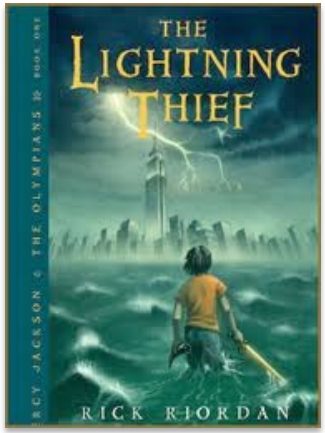
- Teach general comprehension strategies (e.g., main idea, predicting) and disciplinary strategies (e.g., identifying key words in math)
- Less time may be sufficient
- Remember the end goal is for children to get better at extracting meaning from text – not to learn isolated strategies

Knowledge Acquisition and Inference Generation: Teaching Tips & Strategies

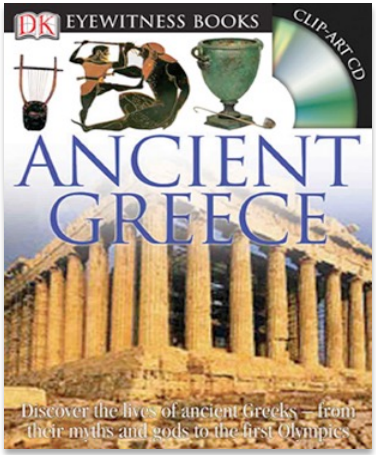
Top 10 Tips for Comprehension Instruction

1. Know your students.
2. Know your goals for instruction.
3. **Teach strategies – especially inferencing to encourage deep understanding of text.**
4. **Focus on developing knowledge and expertise.**
5. Choose appropriately complex and meaningful texts.
6. Teach vocabulary explicitly.
7. Teach sentence level comprehension as needed.
8. Provide different types of activities and tasks to assess comprehension.
9. Encourage self-efficacy, self-regulation, and a growth mindset.
10. Make good habits and set routines in your classroom.

Build Knowledge and Vocabulary through Themed Text Sets



Narrative



Expository

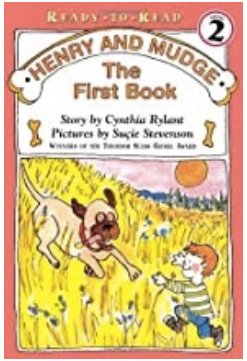
Activate and Assess Knowledge

ANTICIPATION GUIDES

QUESTIONS PRIOR TO READING – TECHNOLOGY CAN MAKE THIS FUN

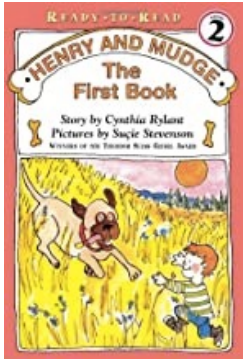
PICTURES AND SHORT VIDEOS

Semantic Feature Analysis: Henry & Mudge



	pointed ears	floppy ears	large & hefty	miniature	curly tail	short hair
Chihuahua						
Poodle						
Basset Hound						
Dalmatian						
Great Dane						

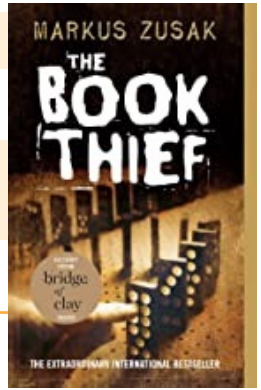
Semantic Feature Analysis: Henry & Mudge



	pointed ears	floppy ears	large & hefty	miniature	curly hair	short hair
Chihuahua	+/-	+/-	-	+	+	+/-
Poodle	-	+	+/-	+/-	+	-
Basset Hound	-	+	?	-	-	+
Dalmatian	-	+	?	-	-	+
Mastiff	-	+	?	-	-	+

Semantic Feature Analysis: The Book Thief

SFA **The Book Thief**	**Sent to internment camp**	**Made to live in ghettos**	**Made to wear a Star of David**	**Sent to crematorium**	**Committed genocide**	**Wore a swastika**	**Forced on death marches**
Jews							
People with disabilities or mental illness							
Nazis							
Hitler Youth							
The German Resistance							
Gestapo							



Semantic Feature Analysis: Renaissance

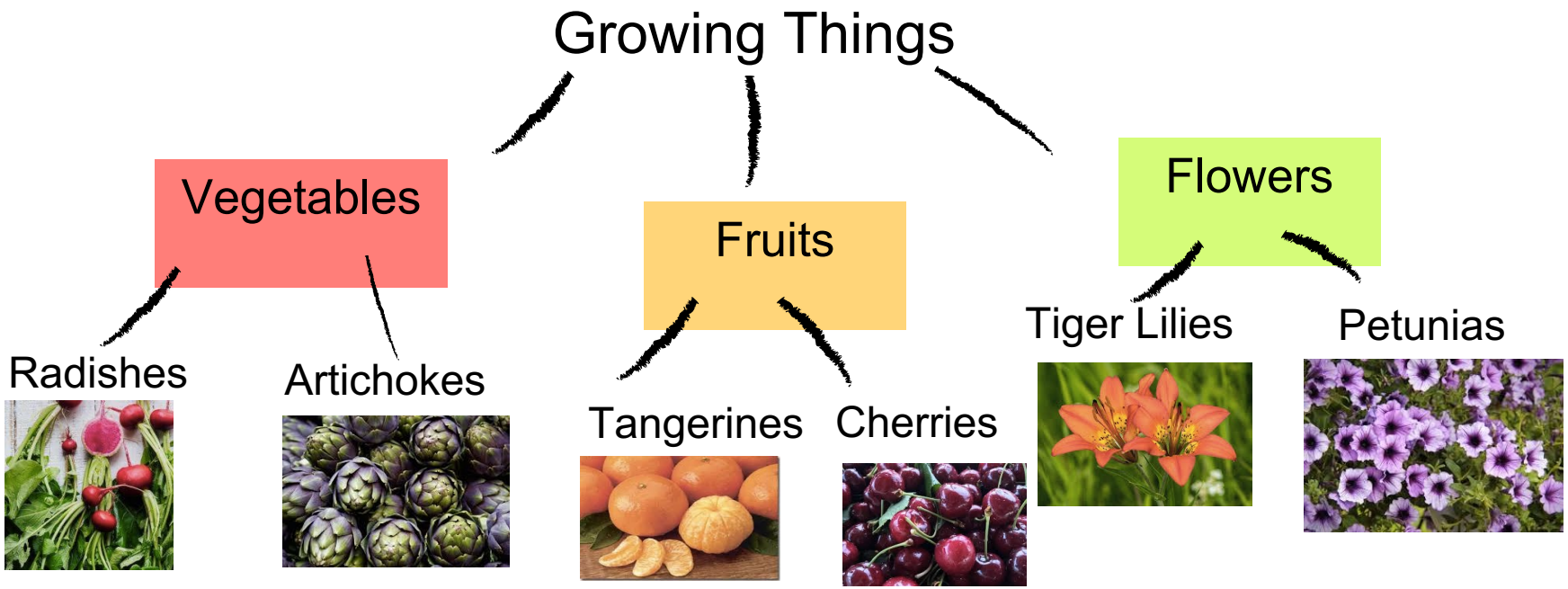
	Scientist	Artist	Architect	Politician	Advocated Humanism	Opposed Reformation	Helped democratize knowledge
Da Vinci							
Gutenberg							
Michelangelo							
Botticelli							
Dante Alighieri							
Machiavelli							
Pope Alexander VI							
Vasari							
Copernicus							
Galileo							
Pope Julius II							

Expert Frameworks & Graphic Organizers

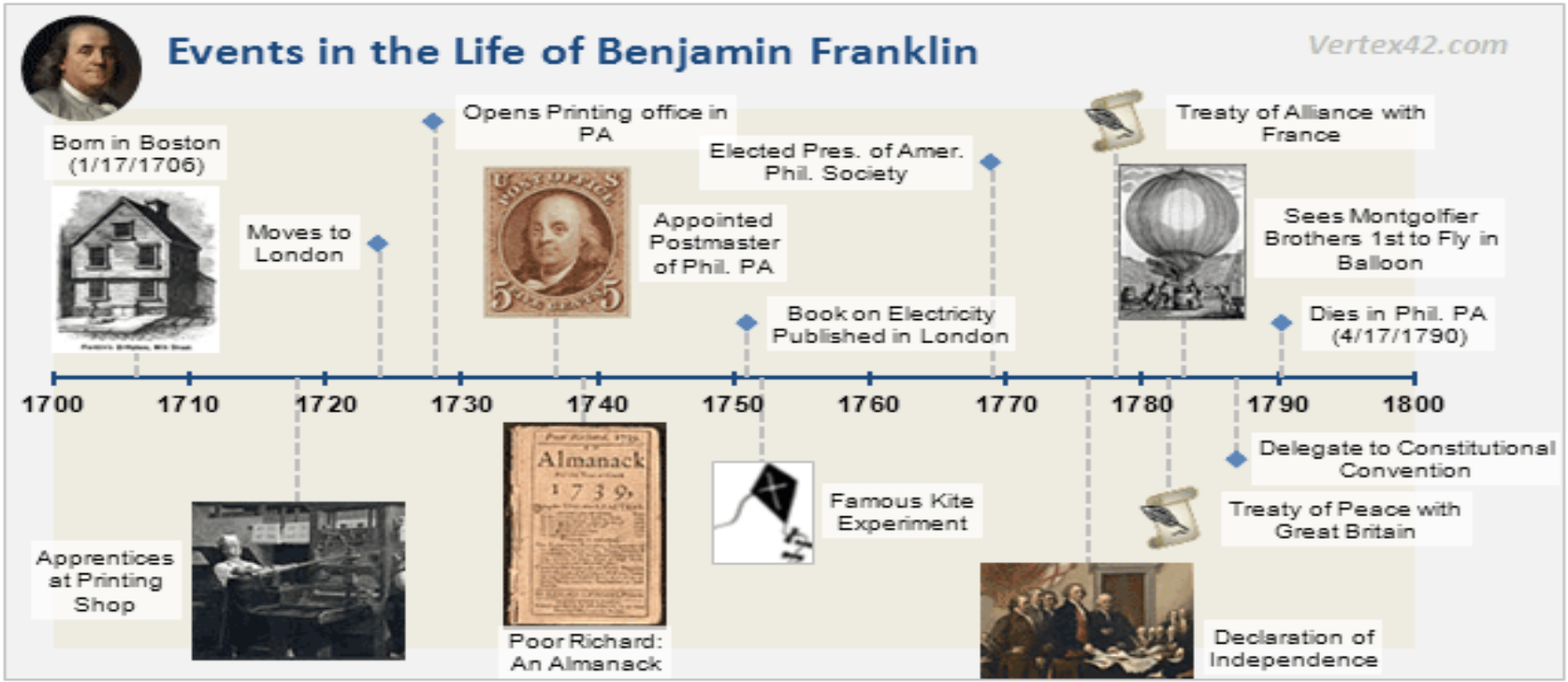
Well-selected graphic organizers should represent (and make explicit) the underlying structure of the concepts in the text and how they are related

Semantic Networks with Preschoolers (Hadley et al., 2018)

Categorical Condition

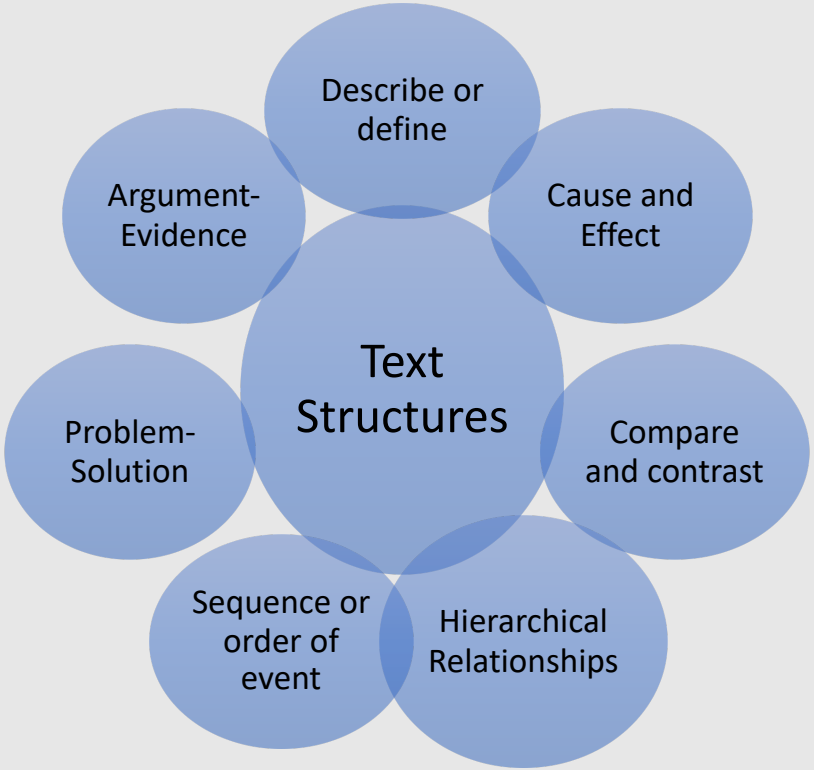


Making Connections



*Timeline created using the **Timeline Template** by Vertex42.com*

Informational Text Structures

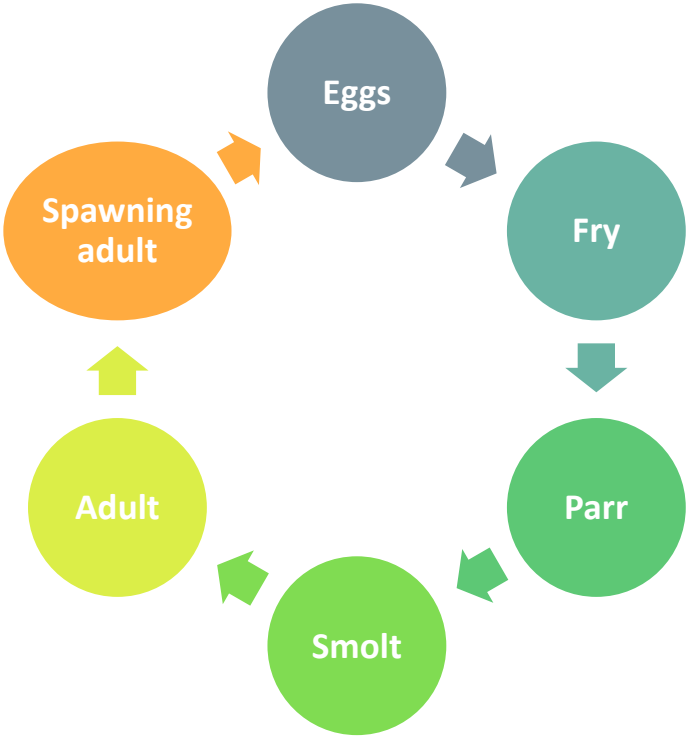


Text Structure Signals

(Halliday & Hasan 1976 in Almasi & Fullerton, 2012)

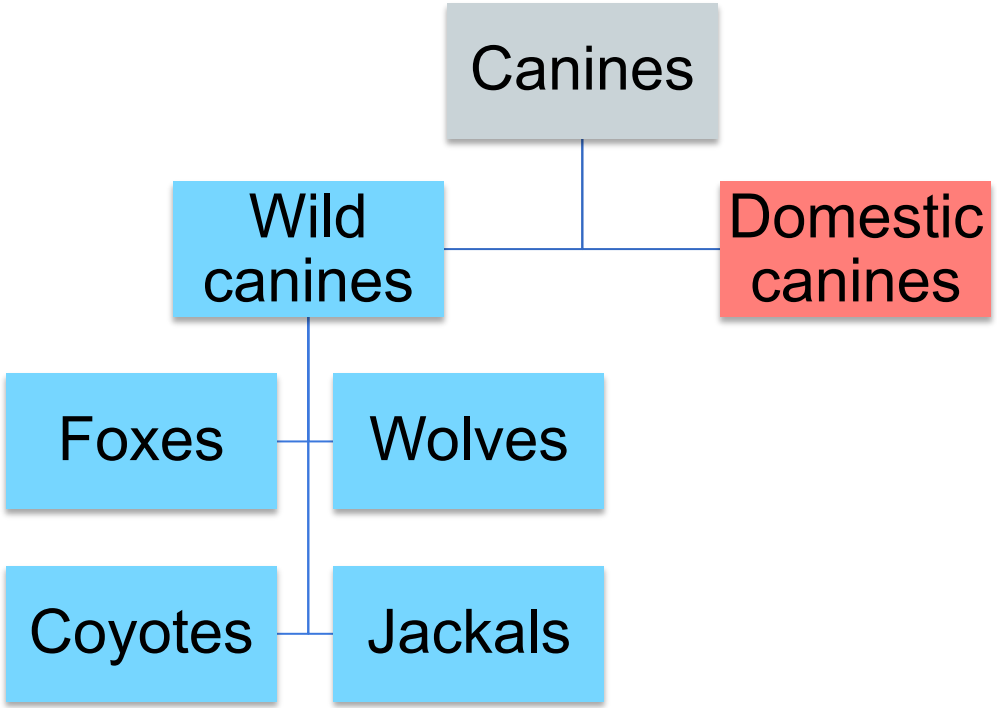
	Function	Examples
additive	Add more information to the sentence	and, also, in addition, furthermore, besides, that is, in other words, moreover, likewise, similarly, in the same way
causal	Indicates causality	so, then, hence, therefore, consequently, because, for this reason, it follows, on this basis, to this end, then
temporal	Indicates time or order	next, before, after, during, when, at the same time, previously, finally, at last, soon, later, meanwhile, at that moment, first, second, third, in conclusion, up to now
adversative	Indicates a contrast	but, however, although, though, yet, only, nevertheless, despite this, on the other hand, in contrast, instead, on the contrary, alternatively, anyhow, at any rate

Sequence: Cycle



Signal Words: after, before, first, initially, soon, while, afterword, during, following, later, not long after, preceding, then, until, at last, finally, immediately, meanwhile, now, when (FCRR, 2016).

Taxonomical Structures Superordinate Categories



Signal Words: related to, is part of, stemming from, classifying, grouped by, for example, looks like, characteristics

Compare & Contrast

Signal Words: although, but, either…or, in common, similar to, as opposed to, compared with, even though, likewise, yet, as well as, different from, however (FCRR, 2016)

Only Honey Bees	Both Bees and Ants	Only Black Ants
• Have wings, fly • Build hive above ground • Produce honey from nectar • Have stingers for self-defense	• Are 6-legged insects • Navigate long distances from hive/nest • Have collaborative colonies • Have a “queen” that lays eggs • Use communication system • Defend the hive/nest • Are active during day	• Crawl but don’t fly • Nest underground • Scavenge, eat smaller insects (aphids) and fungi • Can bite in self-defense

Promoting Connections

Teach

Teach students to make connections

- Within the text
- Across texts
- With their background knowledge and the text

Model

Model making connections by thinking aloud

Note Text Clues

ELA – e.g., character perspective

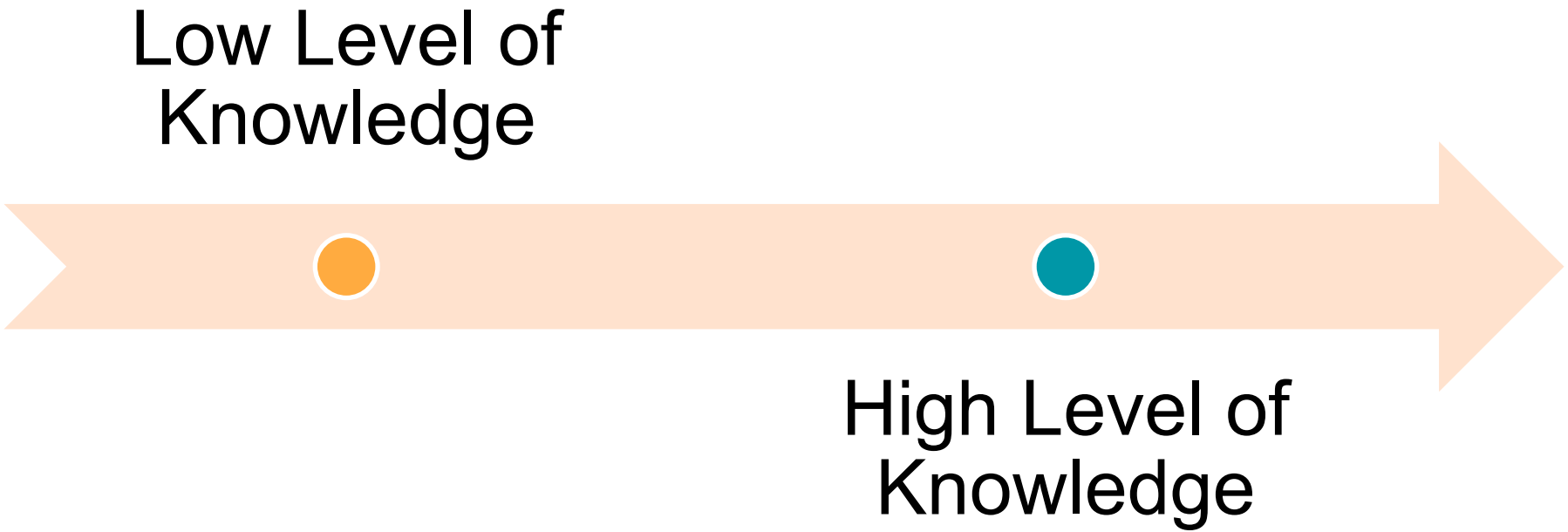
Informational – e.g., text structure markers

Ask

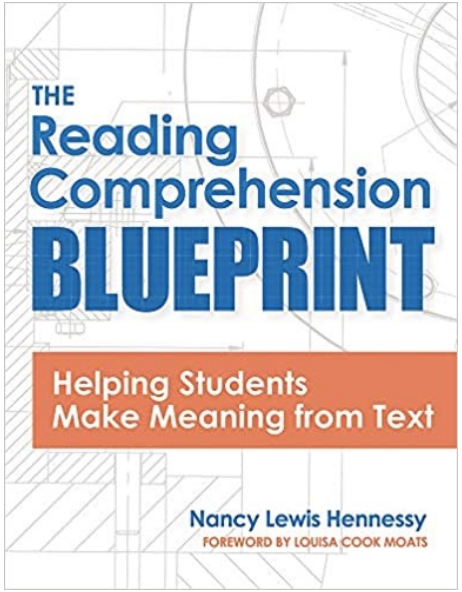
At select points in the text ask,

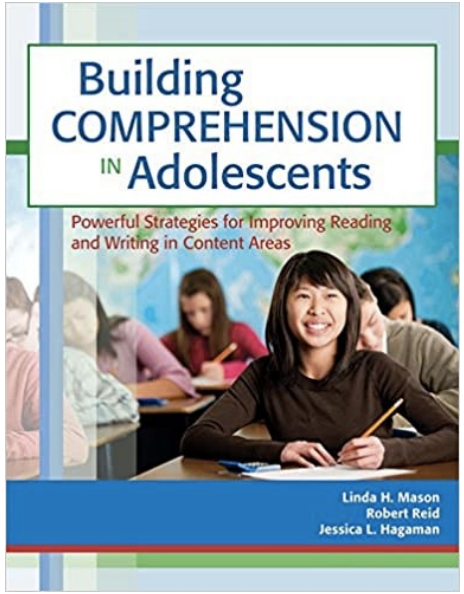
- How does this connect to what we've read before?
- Why is the author discussing this right now in the text?

Consider Students' Expertise when Providing Supports

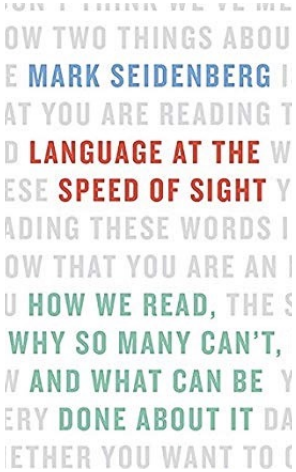


Resources


THE
Reading
Comprehension
BLUEPRINT
Helping Students
Make Meaning from Text
Nancy Lewis Hennessy
FOREWORD BY LOUISA COOK MOATS


Building
COMPREHENSION
IN Adolescents
Powerful Strategies for Improving Reading
and Writing in Content Areas
Linda H. Mason
Robert Reid
Jessica L. Hagaman


Improving
Reading
Comprehension


OW TWO THINGS ABOU
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AT YOU ARE READING T
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ADING THESE WORDS
OW THAT YOU ARE AN
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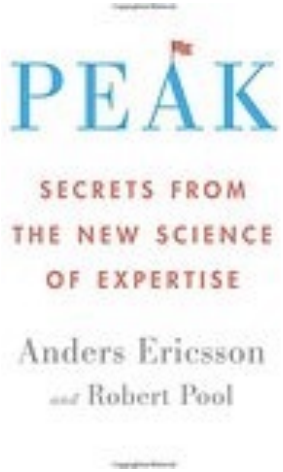
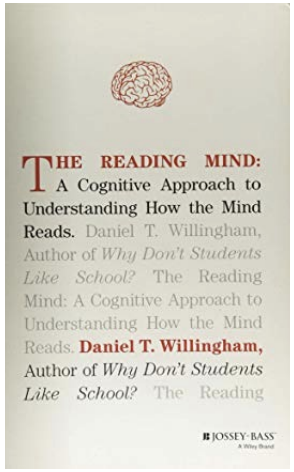
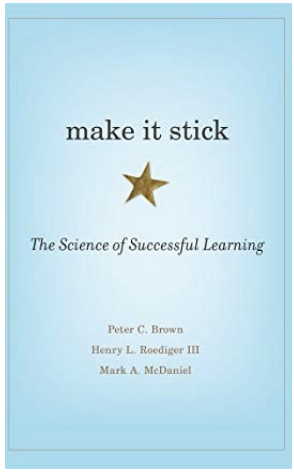
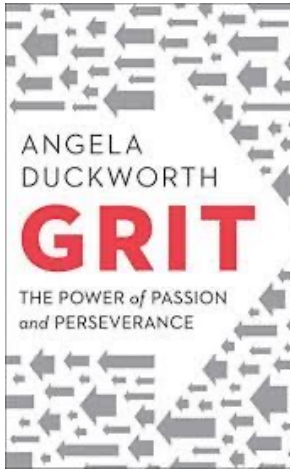
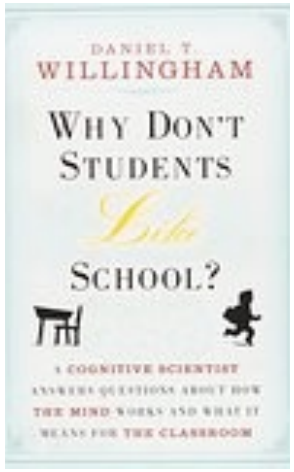
WHY SO MANY CAN'T,
AND WHAT CAN BE
ERY DONE ABOUT IT
IETHER YOU WANT TO


PEAK
SECRETS FROM
THE NEW SCIENCE
OF EXPERTISE
Anders Ericsson
and Robert Pool


THE READING MIND:
A Cognitive Approach to Understanding How the Mind Reads. Daniel T. Willingham, Author of Why Don't Students Like School? The Reading Mind: A Cognitive Approach to Understanding How the Mind Reads. Daniel T. Willingham, Author of Why Don't Students Like School? The Reading
JOSSEY-BASS


make it stick
The Science of Successful Learning
Peter C. Brown
Henry L. Roediger III
Mark A. McDaniel


ANGELA
DUCKWORTH
GRIT
THE POWER of PASSION
and PERSEVERANCE


DANIEL T.
WILLINGHAM
WHY DON'T
STUDENTS
Like
SCHOOL?
A COGNITIVE SCIENTIST
ANSWERS QUESTIONS ABOUT HOW
THE MIND WORKS AND WHAT IT
MEANS FOR THE CLASSROOM

Vocabulary Resources

Coxhead's AWL

- www.victoria.ac.nz/lals/resources/academicwordlist

Hiebert's Common Affixes & Roots

- www.textproject.org/archive/resources/wordzones-for-4000-simple-word-families/.

Word-List Games and Activities

- www.vocabulary.com/lists/218701

Text Project

- http://textproject.org/

Reading Rockets

- http://www.readingrockets.org/

Word Generation

- https://wordgen.serpmedia.org/teacher.html

Florida Center for Reading Research

- www.fcrr.org/

Word of the Day

- https://wordsmith.org/words/today.html

Knowledge Resources

- Daniel Willingham
  - You Tube video (http://www.youtube.com/watch?v=RiP-ijdxqEc)
  - Blog (http://www.danielwillingham.com/daniel-willingham-science-and-education-blog)
- NewsELA
  - https://newsela.com/
- Core Knowledge
  - https://www.coreknowledge.org/
- Knowledge Matters Campaign
  - http://knowledgematterscampaign.org/
- Florida Center for Reading Research (look for Graphic Organizers)
  - https://www.fcrr.org/resources/
- ReadWorks: www.readworks.org
- Scholastic: http://www.scholastic.com
- Lexile: www.lexile.com

Other Trusted Sources

- Institute of Educational Science (IES) & What Works Clearinghouse (WWC) - http://ies.ed.gov/ncee/wwc/
- IRIS - https://iris.peabody.vanderbilt.edu/
- Evidence for ESSA - https://www.evidenceforessa.org/
- Campbell Collaboration - https://campbellcollaboration.org/

IES Practice Guides

http://ies.ed.gov/ncee/wwc/

- **Foundational Skills to Support Reading for Understanding in Kindergarten Through 3rd Grade**
- **Teaching Academic Content and Literacy to English Learners in Elementary and Middle School**
- **Teaching Elementary School Students to Be Effective Writers**
- **Improving Reading Comprehension in Kindergarten Through 3rd Grade**
- **Assisting Students Struggling with Reading**
- **Improving Adolescent Literacy: Effective Classroom and Intervention Practices**
- **Effective Literacy and English Language Instruction for English Learners in the Elementary Grades**
- **Organizing Instruction and Study to Improve Student Learning**

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Questions?

Interested in learning more?

Consider pursuing your Ph.D. in Literacy Studies

Feel free to contact me at

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Thank you for your time and attention today!

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