INSIGHTS ABOUT THE ROLE OF READING AND WRITING IN SCIENCE

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THE CONTEXT OF MY WORK:

- NSF-funded Seeds of Science/Roots of Reading program

- curriculum *and* research

- researchers, developers, and practitioners in science and literacy

TWO EXTREMES

- Text-dominated science programs (mainly reading and writing)
- Hands-on-dominated science programs (mainly doing and talking)

INSPITE OF EVIDENCE THAT:

- text-only approaches to learning science are inadequate (AAAS, 1993; Bransford, Brown, Cocking, 2000; Flavel, 1992; Flavel and Metz, 1995, 2000; NRC, 1996)

- firsthand-experience-only approaches are equally limited (Kouba and Champagne, 1998; Lemke, 1990; Osborne, 2002, 2004; Palinscar and Magnusson, 2001; Postman, 1979)

SCIENTISTS DO LEARN ABOUT THE WORLD BY "DOING"

- explore and ask questions about the natural world
- search for evidence to support ideas
- make inferences from evidence and create explanations
- probe for additional evidence by designing and conducting investigations
- change explanations based on new evidence

But neither scientists nor students can learn all they need to know from "doing" alone

SCIENTISTS ALSO LEARN ABOUT THE NATURAL WORLD BY:

- reading
  - to situate their research
  - to learn about other scientists' expts and findings and critique their conclusions
  - to learn about methods they might use
  - to search for information
- writing
  - to describe what they did and share their findings
  - to critique others' work
- speaking and listening
  - to share their research findings
  - to learn what others' found
  - to engage in discourse in order to question other scientists' claims, evidence, and reasoning

STUDENTS NEED THE SAME OPPORTUNITIES TO LEARN AS SCIENTISTS

- DOING: firsthand experiences where they make observations and conduct investigations
- TALKING: where they communicate and engage in discourse about findings and ideas
- READING: where they connect to the work of other scientists and to things happening outside of the classroom
- WRITING: where they learn to communicate explanations based on evidence

OUR WORK DRAWS FROM AND EXTENDS GREAT WORK OF OTHERS

- Nancy Romance and Michael Vitale (IDEAS)
- Shirley Magnusson and Annemarie Palinscar (GISML)
- John Guthrie (CORI)
- Elizabeth Moje (IQWEST)
- Mike Klentschy (El Centro, CA)
- Jerry Valdez (Fresno, CA)

WE SET OUT TO INVESTIGATE A DIFFERENT MODEL OF SCIENCE INSTRUCTION

Includes balance of learning modalities:

Do-Talk-Read-Write

Employs reading and writing in ways that are authentic to science

What are the advantages and disadvantages of this model compared to typical science instruction?

RESEARCH STUDY

Compared different treatments of similar content
(for several units for Grades 2-3)

	DO	TALK	READ	WRITE
Group 1	X	X		
Group 2			X	X
Group 3	X	X	X	X

SCIENCE OUTCOMES

- Students in the DO-IT, TALK-IT, READ-IT, WRITE-IT classrooms had significantly greater gains in:
  - understanding science concepts
  - understanding science vocabulary

INSIGHT #1: EMPLOY MULTIPLE LEARNING MODALITIES

inquiry-only approaches

hands-on experiences

discussion

text-only approaches

reading

writing

INSIGHT #1:
EMPLOY MULTIPLE LEARNING MODALITIES

A better way
to teach science

hands-on experiences

discussion

reading

writing

BEYOND PRACTICE

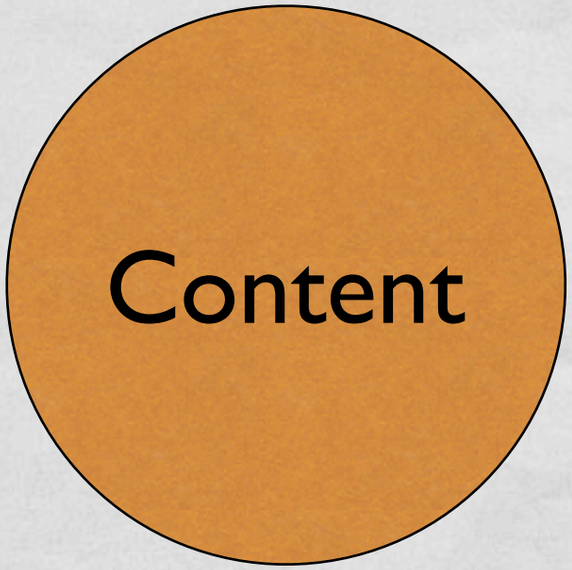
- It's not uncommon for inquiry science curricula to have extensions that involve reading and writing
  - Write a paragraph about....
  - Read this page about...
- This is often done without regard to:
  - the fact that the discipline of science involves unique language and unique ways of reading, writing and engaging in discourse
  - this is something that needs to be learned

DISCIPLINARY LITERACY OF SCIENCE

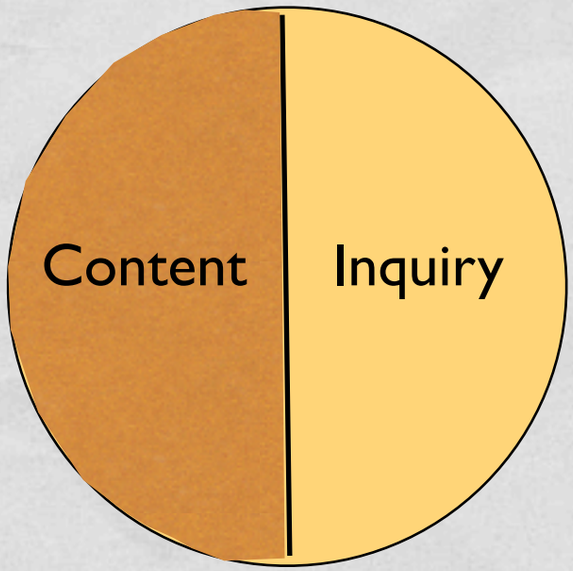
- increasing evidence that explicit instruction is needed to enable students to learn the literacy skills they need to be successful in learning in a subject matter discipline
  - science vocabulary
  - kinds of text features
  - ways of reading
  - structure of information
  - what information to privelege

* important for the sake of learning science

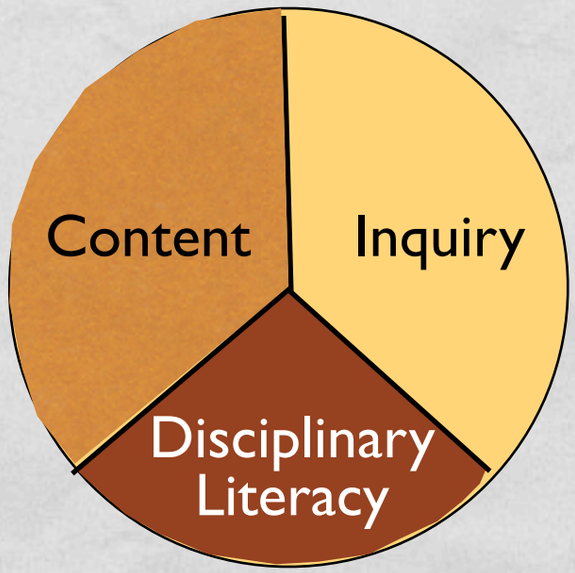
A Time to Act (2009)
Reading in the Disciplines (2009)
National Governors Assocation (2006)
Graham and Perin (2007)
Short and Fitzsimmons (2007)
Shanahan and Shanahan (2008)
Snow and Biancarosa (2003; 2004)



1940's-1960's



1970's-2000



2000 to present

INSIGHT #2
STUDENTS NEED EXPLICIT INSTRUCTION IN DISCIPLINARY LITERACY PRACTICES

- Students need to be taught HOW to:
  - read science text
  - write science text
  - participate in science talk

...and be provided with scaffolded opportunities to practice and gain independence

SHARE OUR PROCESS

- for including a balance of learning modalities
- using reading and writing in ways that are authentic to science

TYPICAL INQUIRY SCIENCE UNIT: DESIGNING GLUE

- CONTENT
  - properties of substances
  - characteristics of mixtures
  - dissolving
  - design process
- INQUIRY
  - observing
  - comparing
  - cause/effect
  - design process


Soda + water
Sticky Test


corn syrup
gelatin
Sticky Test

ENHANCE WITH AUTHENTIC SCIENCE READING

- chose specific purposes for texts that support students' inquiry
- choose roles for text that are authentic to what a scientist would do

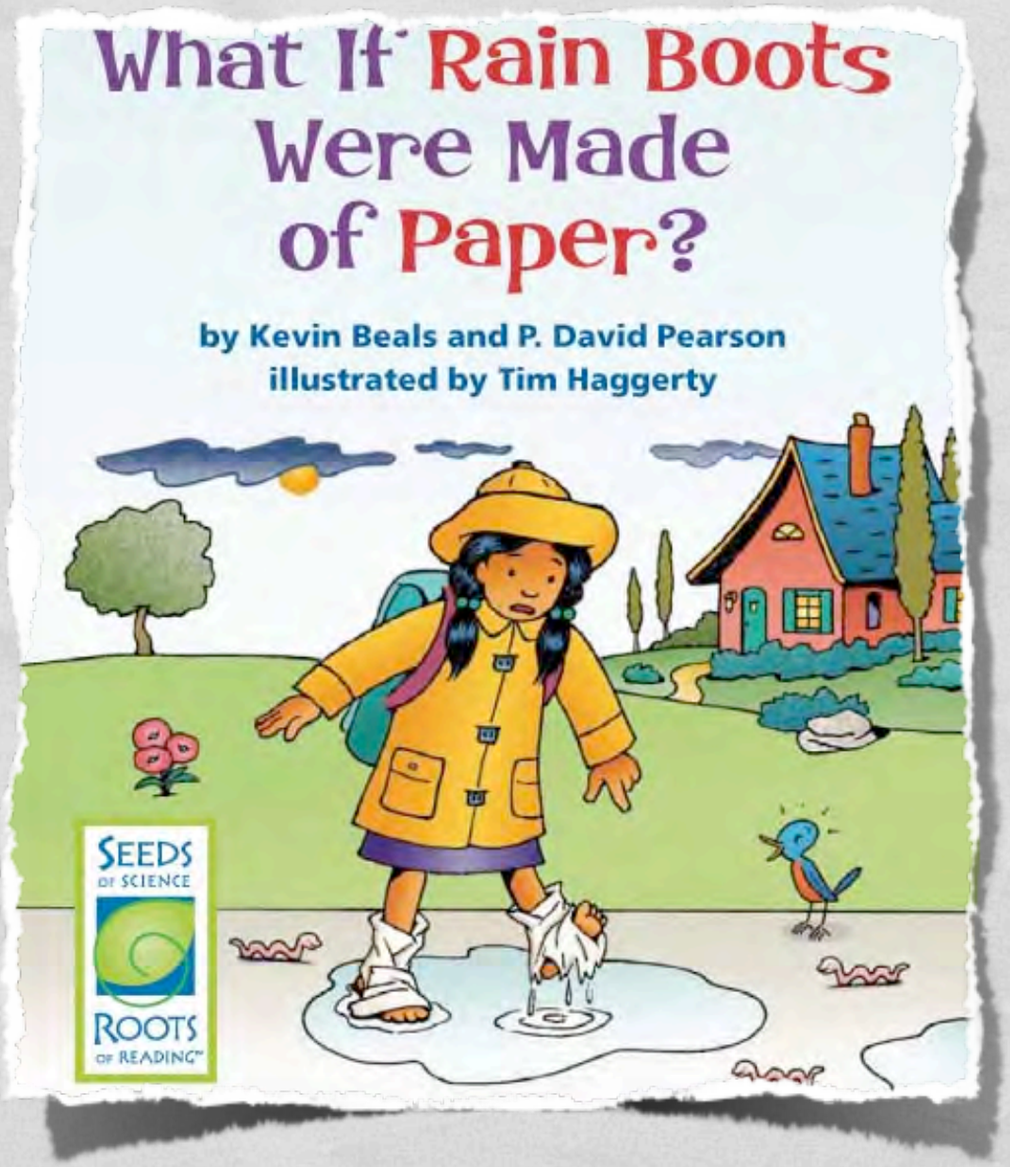
SEE THE RELEVANCE

READ

- students read a book that connects the unit to real world problems

REFLECT

- what are the properties of some everyday objects?



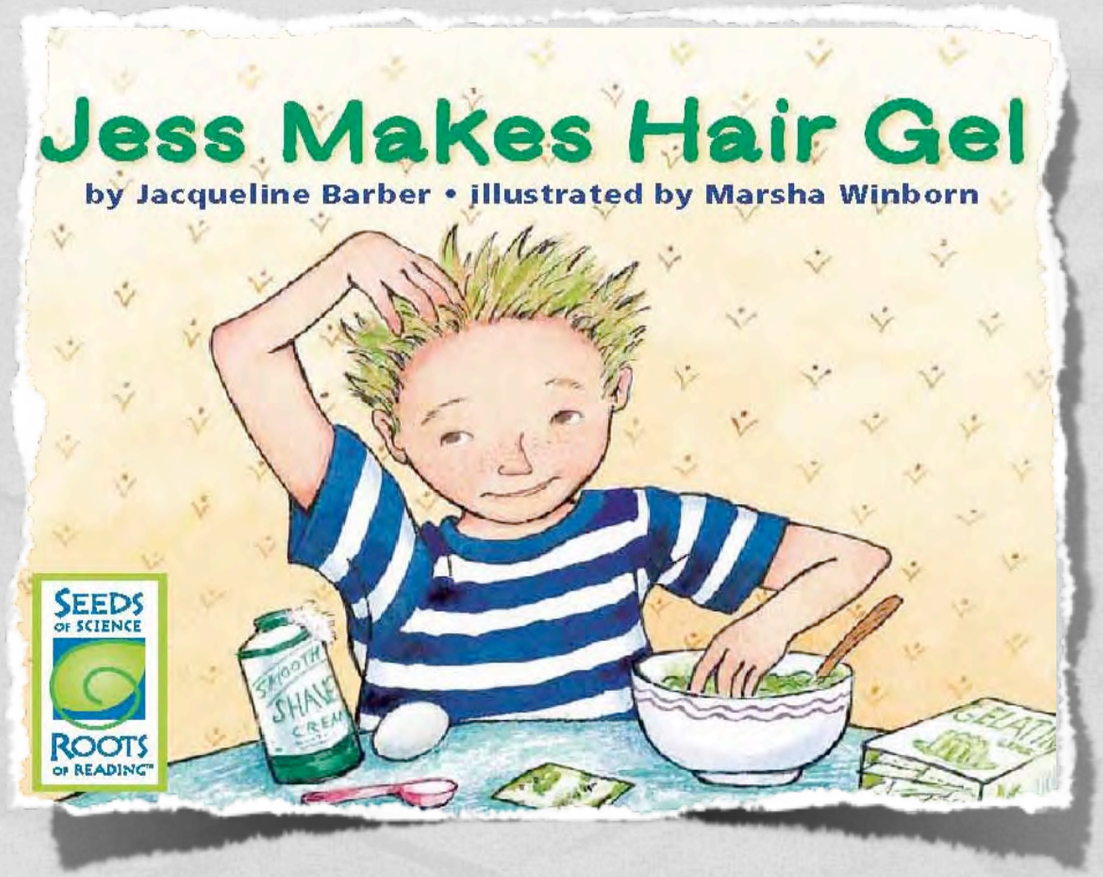
READ ABOUT THE WORK OF OTHER SCIENTISTS

READ

- students read a book that models the design process

REFLECT

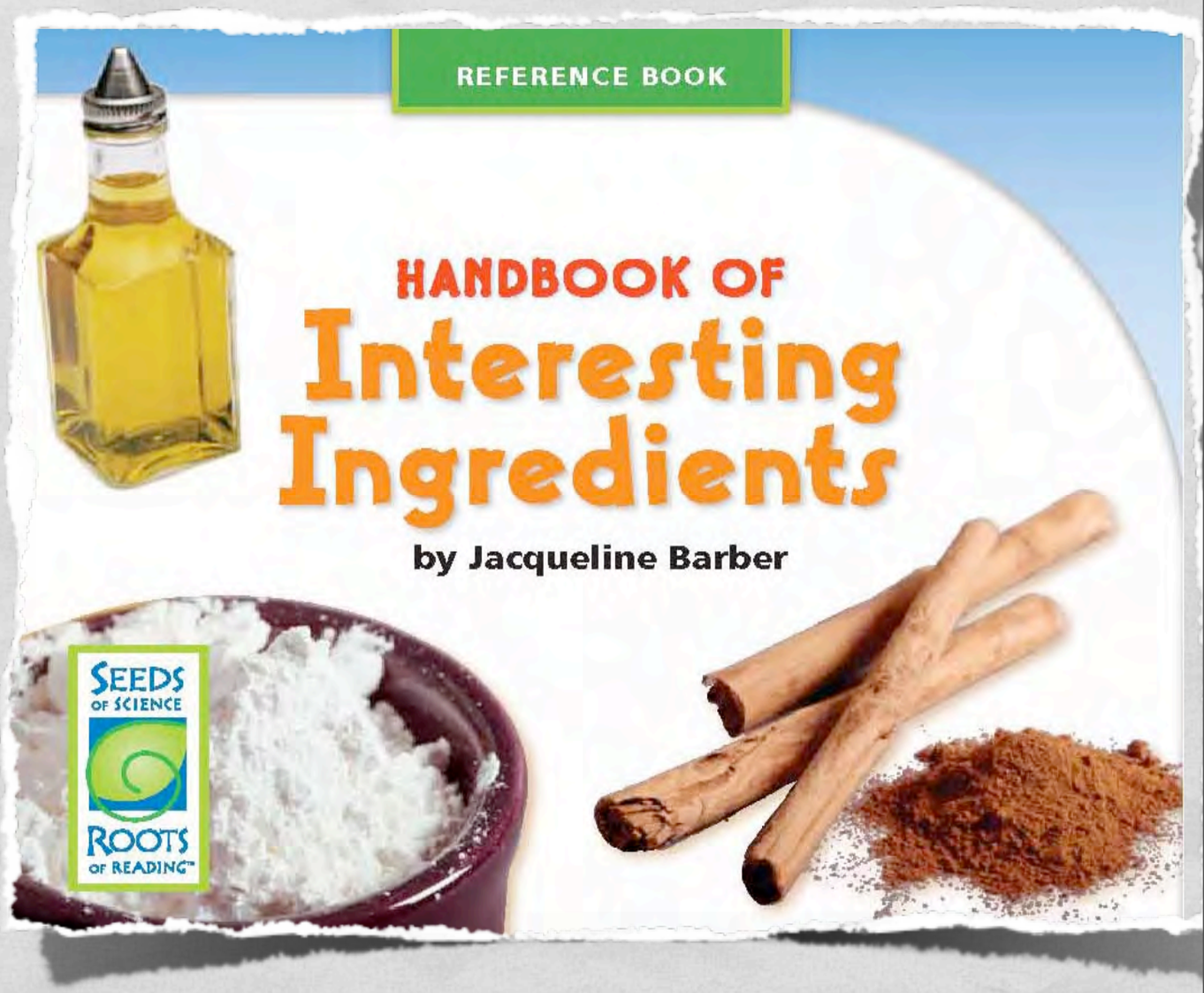
- students reflect on the design process used in the book, and how they could use this same property-driven design process to refine their glue mixtures



SEARCH FOR ADDITIONAL EVIDENCE

READ

- students search for secondhand evidence about ingredients that might have the properties needed to make good glue



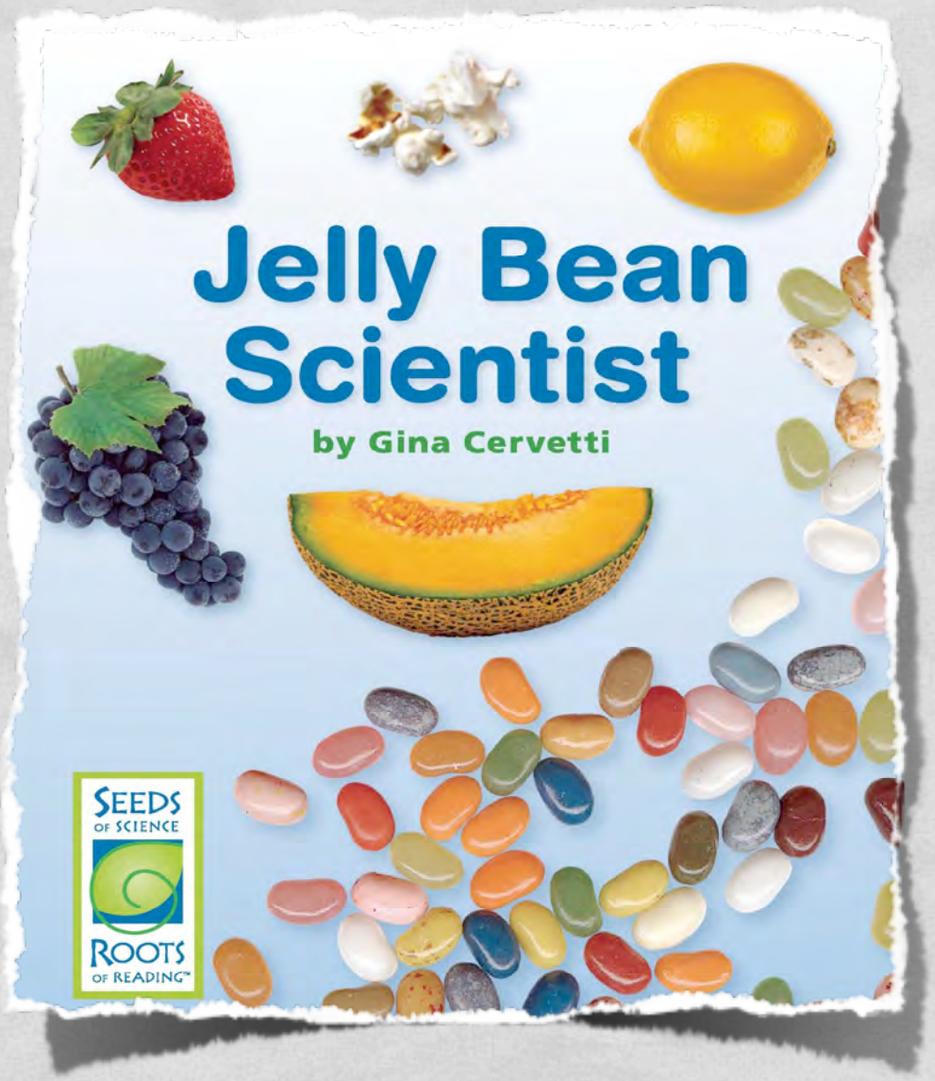
READ ABOUT WORK FROM THE "FIELD"

READ

- students read about a food scientists who designs and tests new jelly beans

REFLECT

- students reflect on how their design process is like that used by the jelly bean scientist



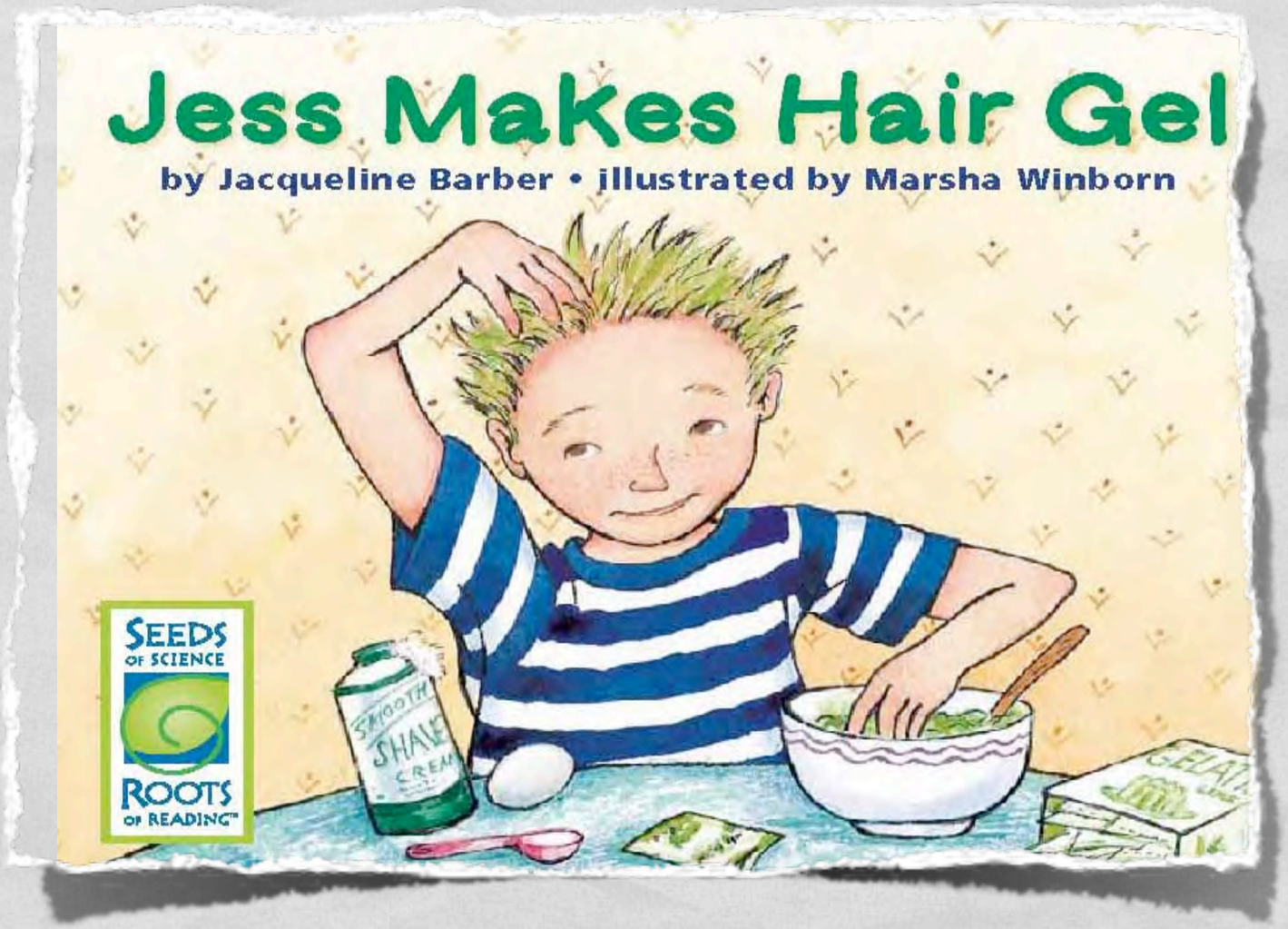
Five authentic roles that text can play in supporting inquiry

ROLE: PROVIDE CONTEXT

- introduce domain and/ or context
- invite students to engage with the context
- connect to the world outside the classroom

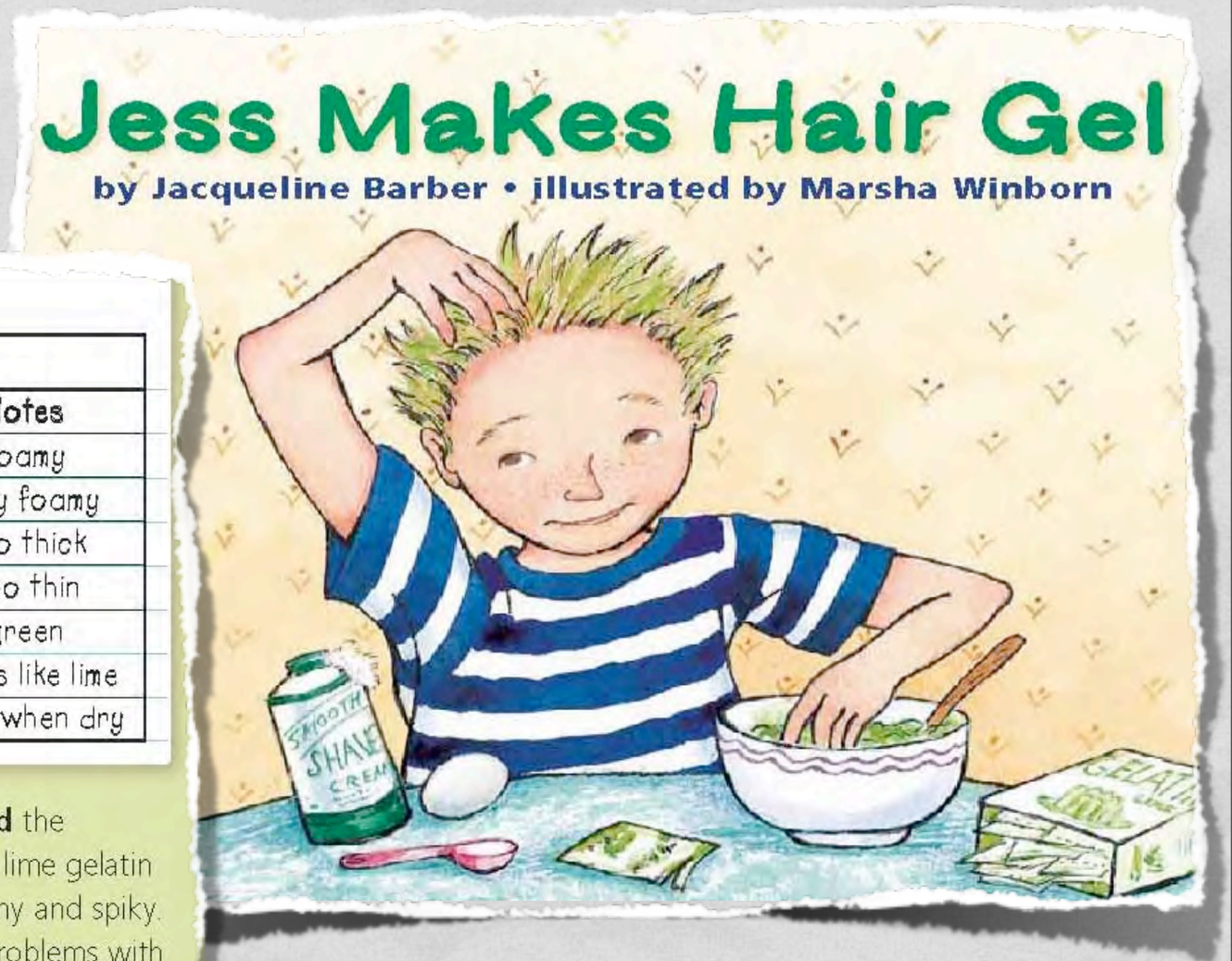
ROLE: MODEL

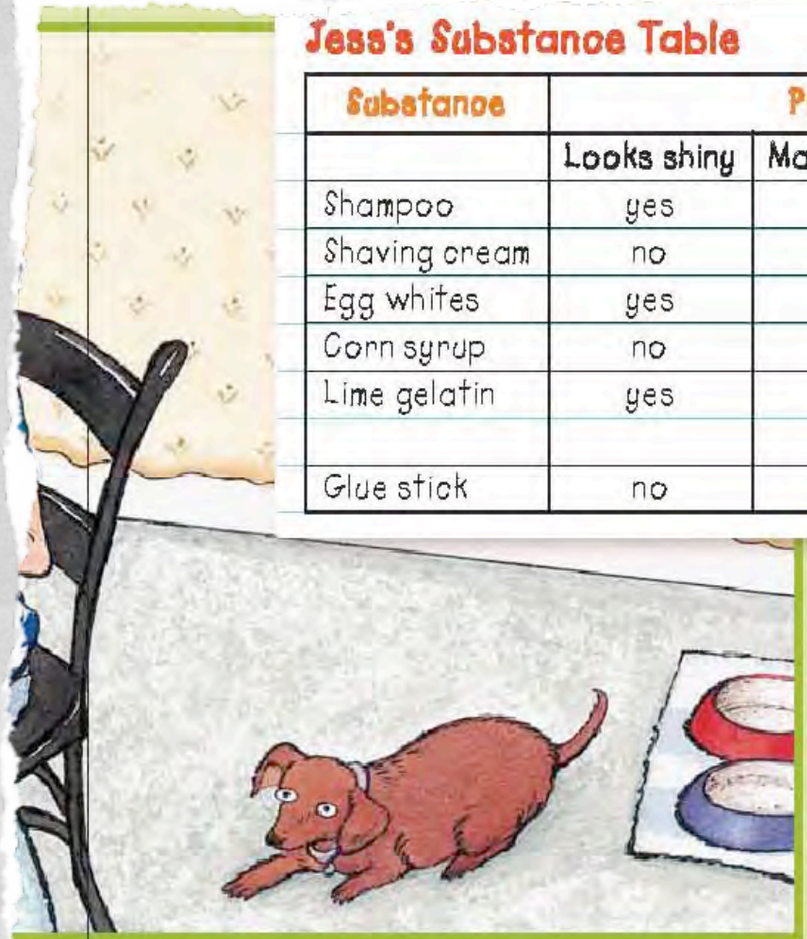
- model inquiry processes
- model nature of science
- model literacy processes



ROLE: SUPPORT SECONDHAND INVESTIGATIONS

- provide data for students to interpret





Jess's Substance Table

Substance	Properties		
	Looks shiny	Makes spikes	Notes
Shampoo	yes	no	foamy
Shaving cream	no	yes	very foamy
Egg whites	yes	no	too thick
Corn syrup	no	no	too thin
Lime gelatin	yes	yes	green
			smells like lime
Glue stick	no	yes	hard when dry

Jess **compared** the substances. Only lime gelatin made his hair shiny and spiky. But there were problems with the lime gelatin. Who wants green hair? Who wants to smell like lime?

ROLE: SUPPORT FIRSTHAND INVESTIGATIONS

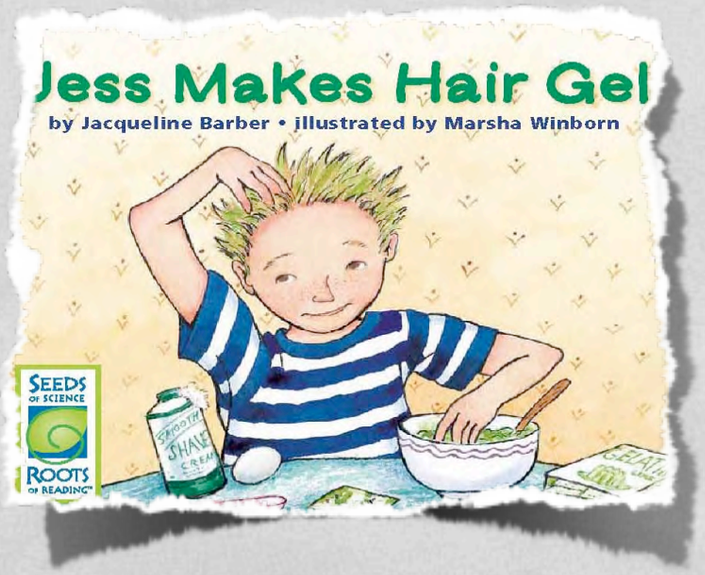
- provide information that facilitates firsthand investigations

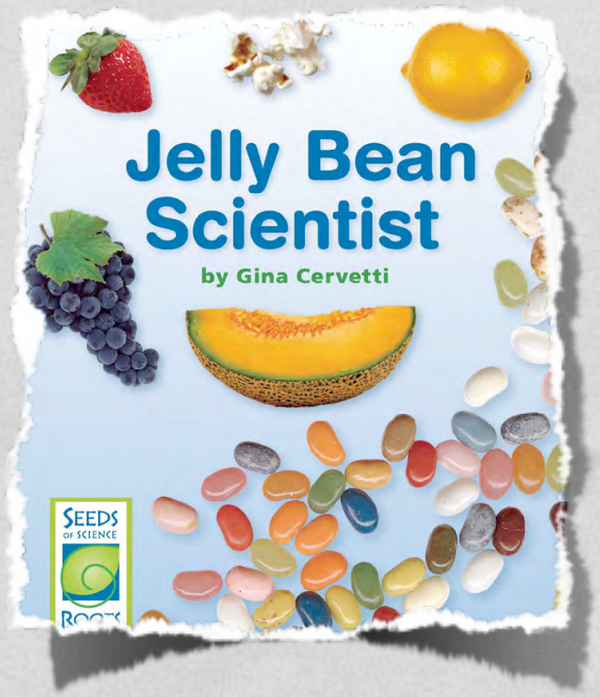
- support students in making sense of firsthand investigations

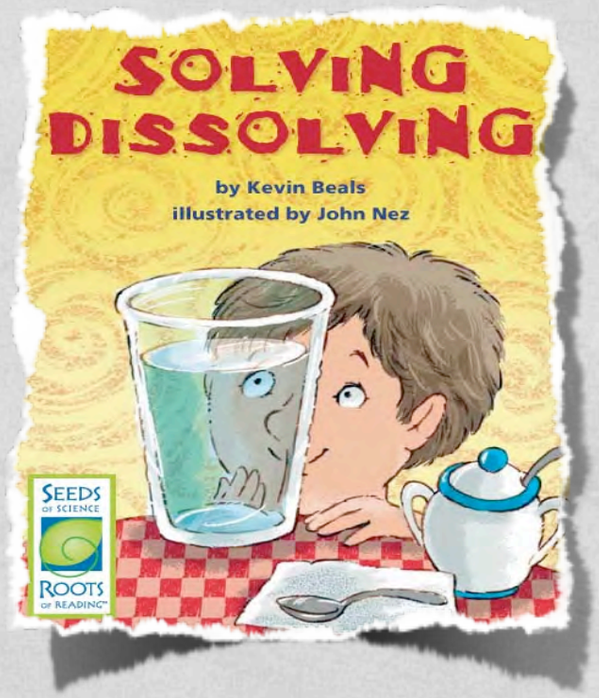
- inspire firsthand investigations

ROLE: DELIVER CONTENT

- deliver science information
- provide information and explanations about unobservable phenomena







THE ROLES OF TEXT IN INQUIRY SCIENCE

provide context	connect to the world outside the classroom
deliver content	**read to learn about science**
model	demonstrate a process or disposition
support secondhand investigations	provide data for students to interpret
support firsthand investigations	provide information for investigations

AUTHENTICITY IN SCIENCE

provide context	→	scientists read to situate research
deliver content	→	scientists read to learn findings
modeling	→	scientists replicate others' procedures and experiments
support secondhand investigations	→	scientists read and interpret others' data and findings
support firsthand investigations	→	scientists use reference books

INSIGHT #3:
ENGAGE STUDENTS IN FIRSTHAND AND SECONDHAND INVESTIGATIONS TO MAKE SENSE OF THE WORLD

Should students read before or after their firsthand investigations?

It depends....

TEXT AND INQUIRY

		provide context	**deliver content**	model	support secondhand inquiry	support firsthand inquiry
1	explore the topic	x	**x**	x	x	
2	ask a question			x	x	
3	make a hypothesis		**x**	x		
4	plan and conduct an investigation			x		x
5	record and organize data			x		x
6	analyze results			x	x	
7	make an explanation based on evidence	x	**x**	x	x	
8	ask a new question			x	x	
9	communicate results			x		

TEXT AND LEARNING CYCLE

	Provide context	**Deliver content**	Model	Support secondhand investigations	Support firsthand inquiry
Engage	X		X		
Explore	X	**x**	X		
Explain	X	**x**	X	X	X
Extend		**x**	X	X	X
Evaluate			X	X	X

INSIGHT #4:
USE BOOKS BEFORE, DURING AND AFTER FIRSTHAND ACTIVITIES

- Before firsthand activities
- During firsthand activities
- After firsthand activities

....depending on what role they play in supporting inquiry

WRITING IN SCIENCE

Science note-booking is a great practice, enabling students to write to reflect

However, there's more to writing in science....

DIFFERENT GENRES OF SCIENCE WRITING

- procedural text
- scientific explanations
- descriptive text
- compare/contrast
- scientific reports
- note-taking
- process descriptions
- question/answer

ENHANCE WITH AUTHENTIC SCIENCE WRITING OPPORTUNITIES

- selected an appropriate genre of science writing matched to the activities of the unit
- created repeated opportunities for students to engage with that genre

DESIGNING GLUE SEQUENCE

- Introduce writing genre of procedural text
- Provide models
- Scaffolded practice
- Gradual release of responsibility

CHOOSE ONE GENRE AT A TIME

systematic observation →	note-taking or descriptive writing
understanding processes →	process description
conceptual understanding →	scientific explanations
comparison →	compare/contrast

INSIGHT #5: ENGAGE STUDENTS IN WRITING IN A RANGE OF SCIENCE GENRES

- Writing to reflect is a very valuable practice, but not the only important kind of writing

- There are multiple science writing genres that will enable students' success

- Choose ONE appropriate writing genre per science unit and provide repeated opportunities for students to practice

FINAL INSIGHT:
READING IS AN ACT OF INQUIRY

Firsthand Investigations	Reading Text
both are enacted to discover something	
science inquiry and reading comprehension are both the central meaning-making processes in their respective domains	
both rely on a preponderance of evidence to test claims	
both rely on similar strategies	

INQUIRY STRATEGIES ARE COMPREHENSION STRATEGIES

- making inferences
- posing questions
- summarizing
- making predictions
- drawing conclusions
- comparing

INQUIRY STRATEGIES ARE COMPREHENSION STRATEGIES

- although the source of the evidence differs the cognitive processes used in each domain are similar
- students can learn to flexibly apply strategic thinking in both domains

IN SUMMARY:

- Employ multiple modalities—DO, TALK, READ, WRITE
- Provide explicit instruction in disciplinary literacy skills and strategies—read science text, write science text, and participate in science talk
- Engage students in firsthand and secondhand investigations to make sense of the world

IN SUMMARY (CONT):

- Use books before, during and after firsthand activities, depending on the role they play in supporting inquiry
- Engage students in writing in a range of science genres (one per unit!)
- Embrace reading as an act of inquiry!

SEEDS OF SCIENCE
ROOTS OF READING

- Gina Cervetti and Jacqueline Barber. (2009) Text in Hands-on Science. In *Science and Children*. (November 2009)

- Gina Cervetti and Jacqueline Barber. (2008) Text in Hands-on Science. In E. Hiebert (Eds.) *Finding the Right Texts*. New York: Guilford.

- Gina Cervetti, P.David Pearson, Marco A. Bravo and Jacqueline Barber, (2007) Reading and Writing in the Service of Inquiry-Based Science, Chapter in R. Douglas, M. Klentschy, and K. Worth (Eds.), *Linking science and literacy in the K-8 classroom.* Arlington, VA: NSTA.

- Gina Cervetti, P.David Pearson, Jacqueline Barber, Elfrieda Hiebert, and Marco A. Bravo. (2007) Integrating literacy and science: The research we have, the research we need. In M. Pressley, A.K. Billman, K. Perry, K. Refitt, and J. Reynolds (Eds.) *Shaping literacy achievement*. New York: Guilford.

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