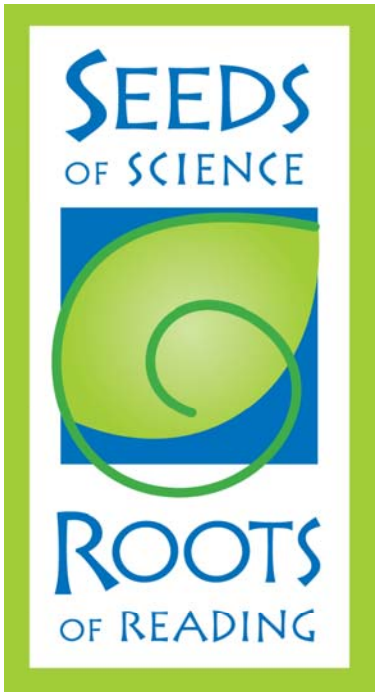
Seeds of Science/Roots of Reading: A Model of Distributed Literacy



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Set out to learn:

- In what ways can reading, writing, listening, and speaking support science learning?
- How can the context of science support literacy learning?

Notable Characteristics:

- Research *and* development
- Science *and* literacy
- Team with multiple expertise

  (educational researchers, curriculum developers, professional developers, scientists and practitioners)

Seeds of Science
Roots of Reading

- Curriculum for Grades 2-5
- Funded mainly by National Science Foundation
- Complete by Fall 2010

The SEEDS and ROOTS Approach involves students in:

- Deep forays into learning about the natural world
- Searching for evidence through firsthand experiences and text in order to construct more and more accurate and complete understandings of the natural world
- Engaging in written and oral discourse with the goal of communicating evidence-based explanations, and evaluating and revising the explanations

In Use

- Implementation pilots in 13 states (CA, GA, KY, NH, MA, MN, NJ, NY, OH, TN, TX, UT, VA)
- As a science program with extra benefits (Cleveland—90 teachers in 18 schools)
- As a science and literacy program (McPherson School in NAPA—charter school)
- As a supplementary literacy program (Minneapolis—80 summer school sites)
- As an ELD program (Santa Barbara, CA)

Seeds & Roots @ middle school

- For Grades 6-8 (funding by the Bill and Melinda Gates Foundation)
- Just begun work, in Jan 2010

Structure of the Session:

- Share information about the approach and effectiveness of SEEDS/ROOTS elementary program
- Close look at approaches (and common pitfalls) to integrating science and literacy
- Early thoughts about how we plan to apply what we've learned to the middle school context

An Example from *Designing Mixtures*

A 4-week unit for 2nd-3rd graders

- Properties of substances
- Mixtures
- Dissolving
- Design process

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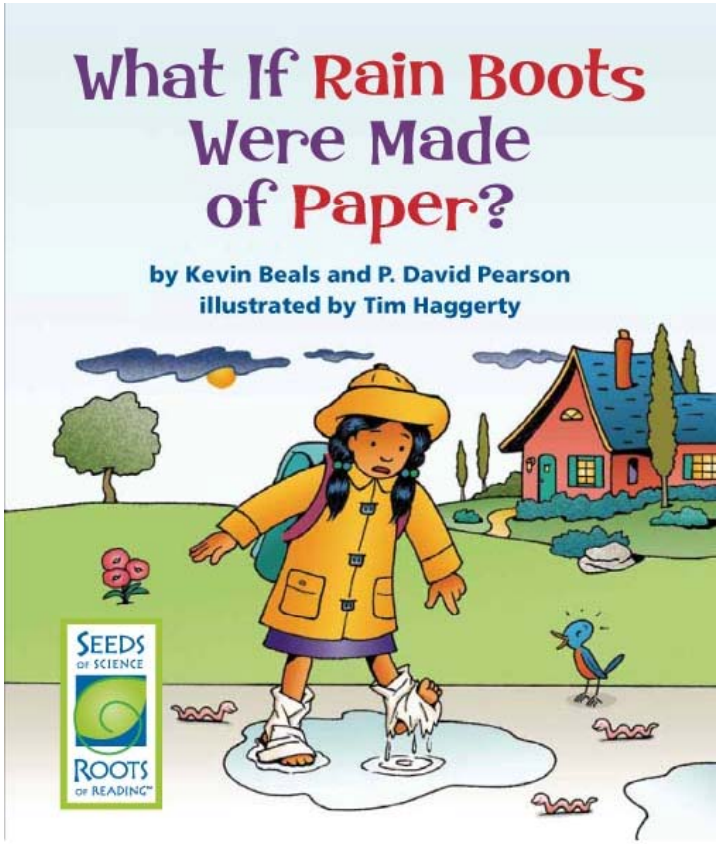
See the relevance

Read

Students read a book that connects the unit to real world problems



Set up sticky tests

Do

Students test ingredients and mixtures to learn more about possible glue ingredients and to select those that are stickiest

Conduct sticky tests

Do

Students collect firsthand evidence about which possible glue ingredients are stickiest

Reflect

Students evaluate results and decide which ingredients to use to make glue

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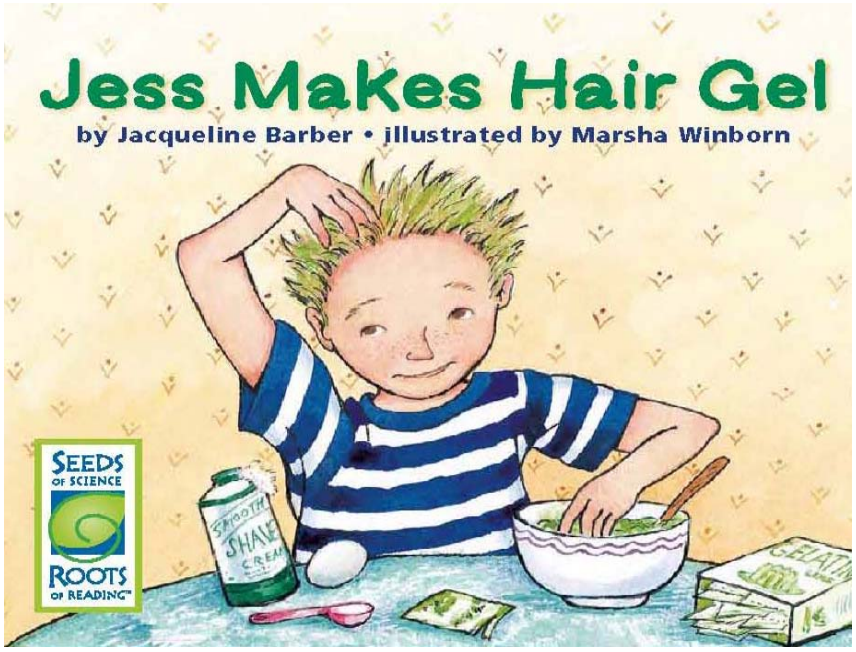
Read about the work of other scientists

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

Set up strength tests

Do

Students conduct more ingredient tests, this time focusing on the property of strength

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Conduct strength tests

Do

Students collect firsthand evidence about which ingredients are strongest

Write

Students record their results

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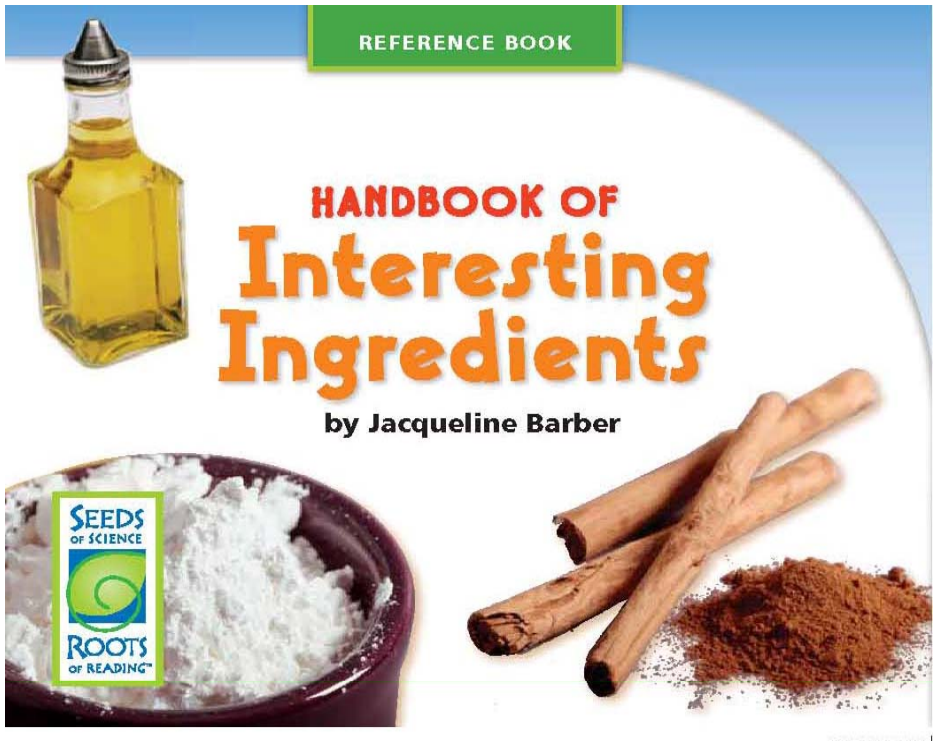
Search for additional evidence

Read

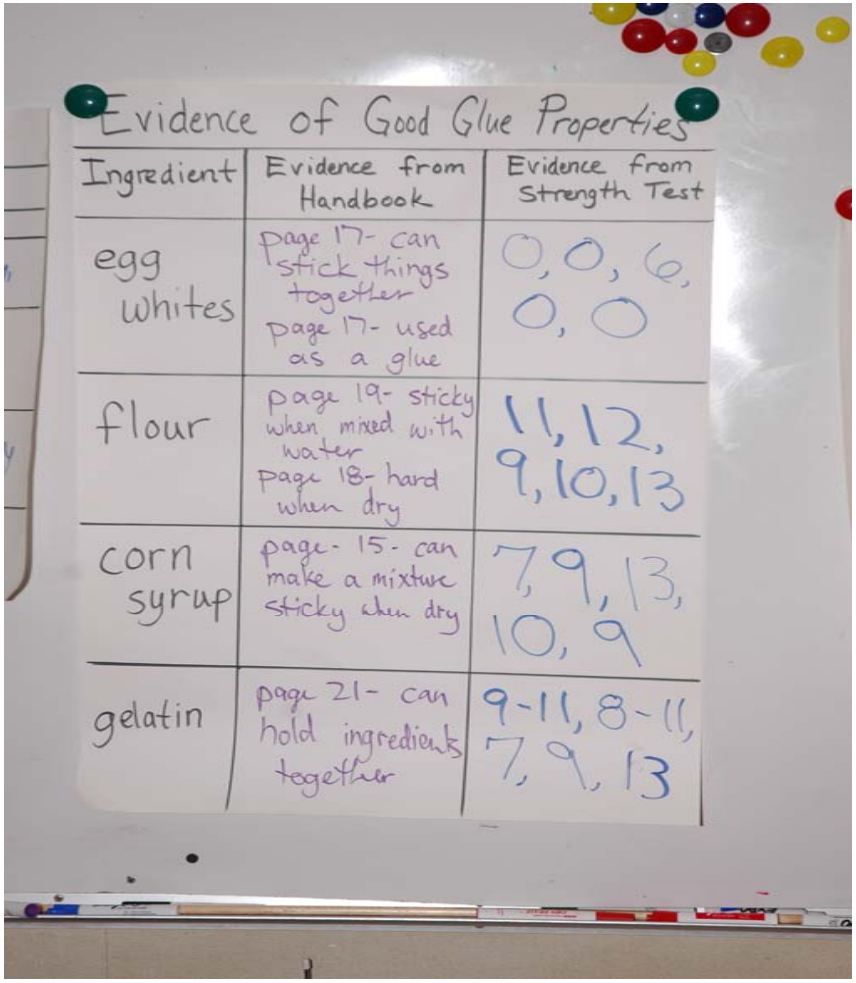
Students search for secondhand evidence about ingredients that might have the properties needed to make good glue



Evaluate evidence and make decisions

Reflect

Students evaluate what they have learned about ingredients from both first and secondhand sources and make decisions about what combination of ingredients best meets their design goals



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Create own glue recipe

Write

Students write procedures for making the best glue based on the evidence they have collected so far

Revise

Then they revise their procedures based on feedback from a buddy who tries to make glue following the procedure

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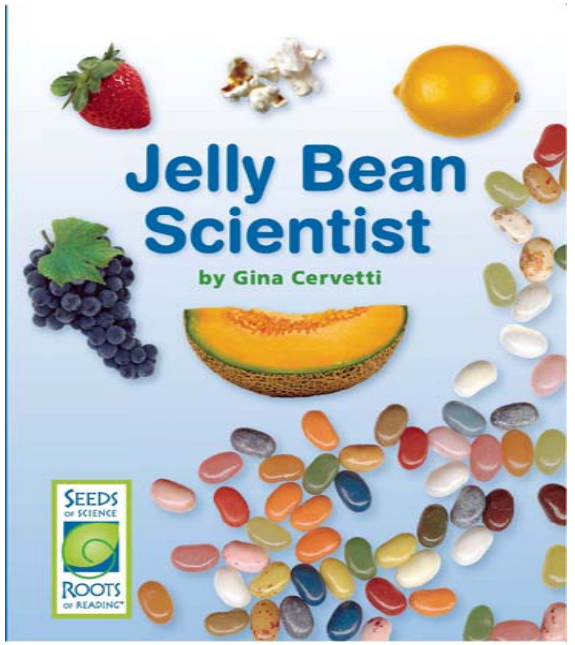
Read about other work from “the field”



Read

Students read about a food scientist who designs and tests new jelly beans

Reflect

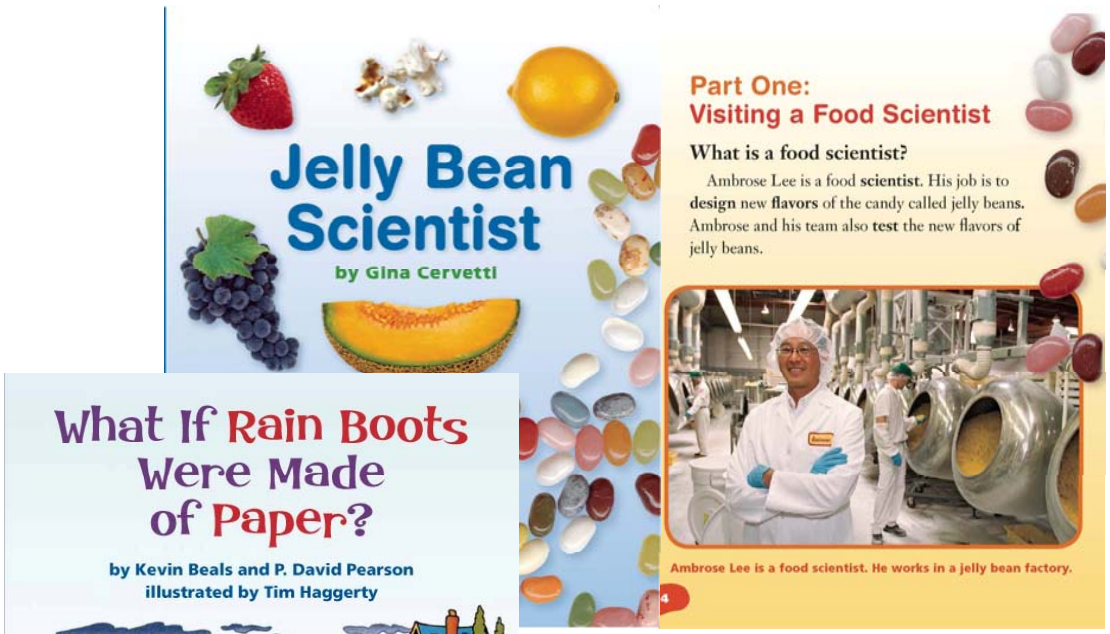
Students reflect on how their design process is like that used by the jelly bean scientist

Read-Do-Talk-Read-Talk-Do-Write-Read-Talk-Write-Talk-Do

- Read-it, Write-it, Do-it, Talk-it
- Literacy and Science are inextricably integrated
- 100% science; literacy as a tool
- Text is used to play a variety of roles in supporting inquiry science

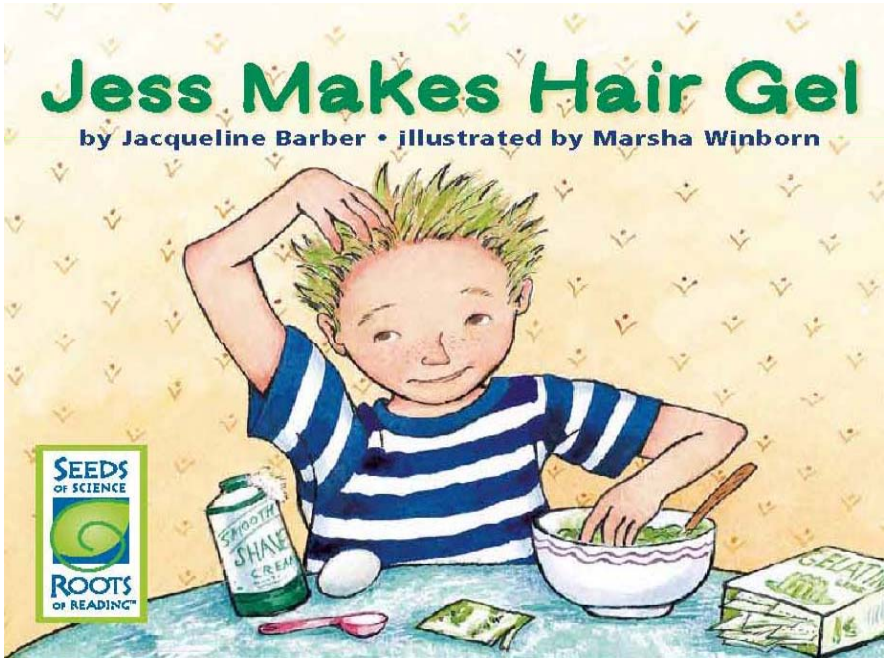
Role: Provide Context

- Introduce domain and/or context
- Invite students to engage with the context
- Connect to the world outside the classrooms



Role: Model

- Model inquiry processes
- Model nature of science
- Model literacy processes



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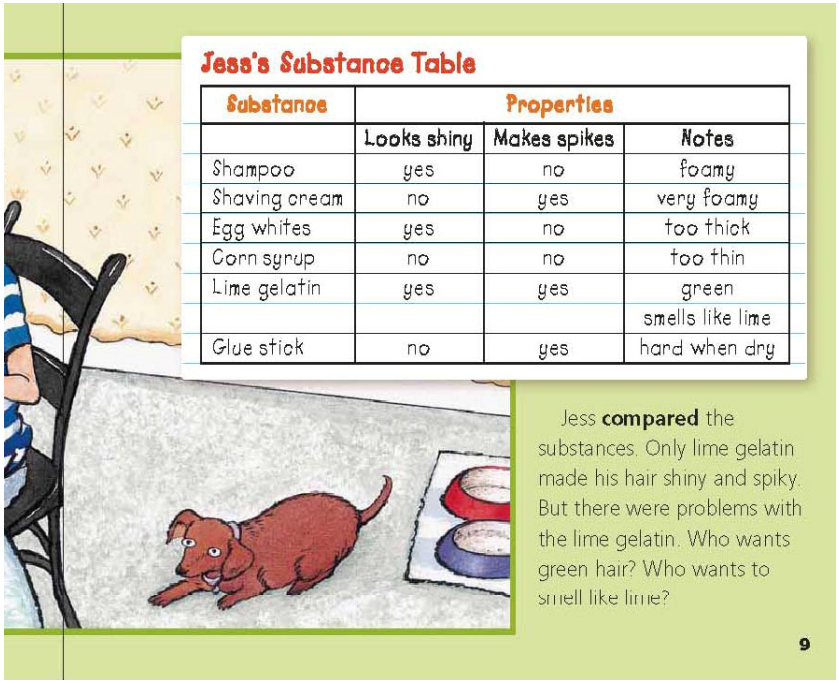
Role: Support secondhand investigations

- 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?

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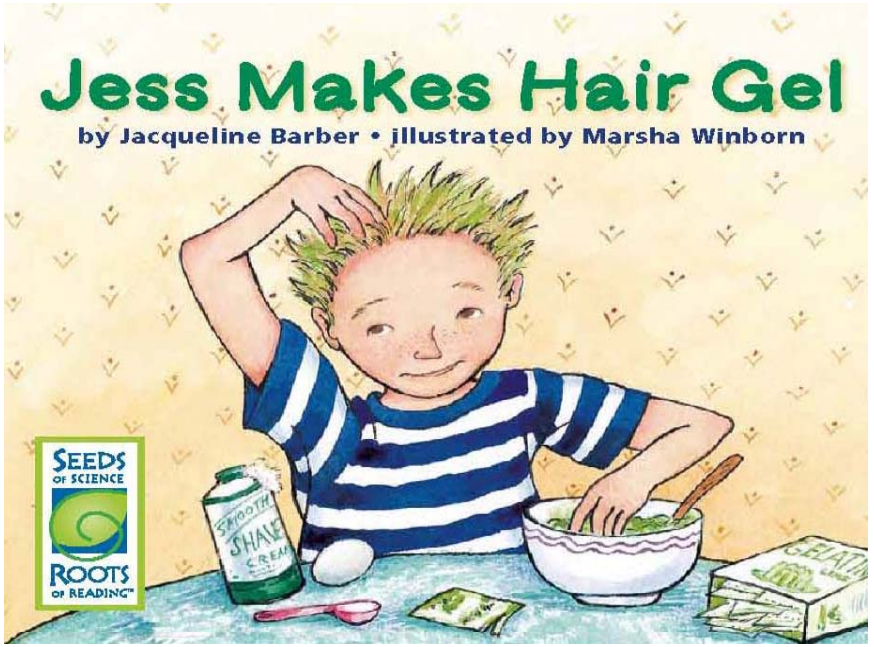
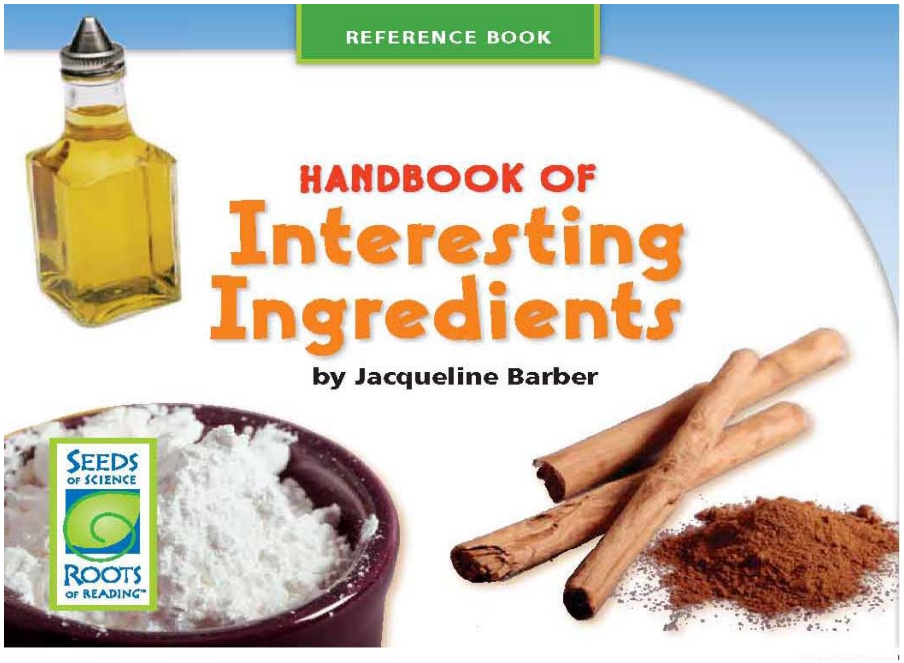


Role: Support firsthand investigations

- Provide information that facilitates firsthand investigations
- Support students in making sense of firsthand investigations
- Inspire firsthand investigations



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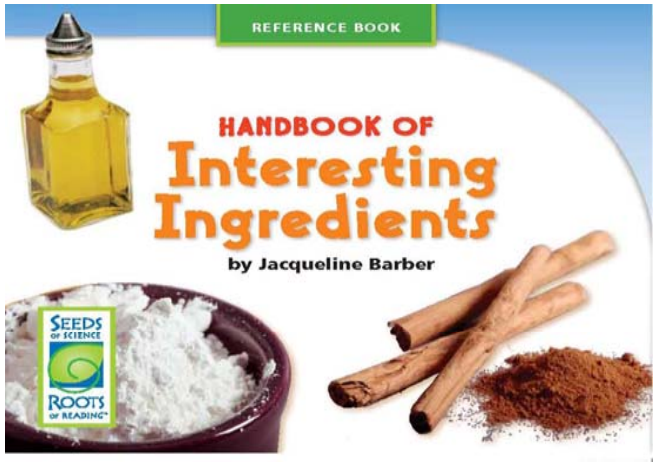
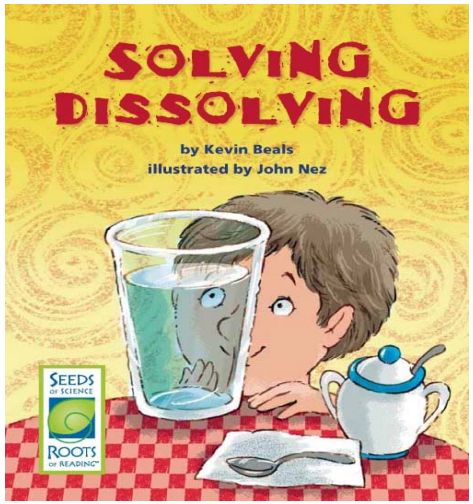
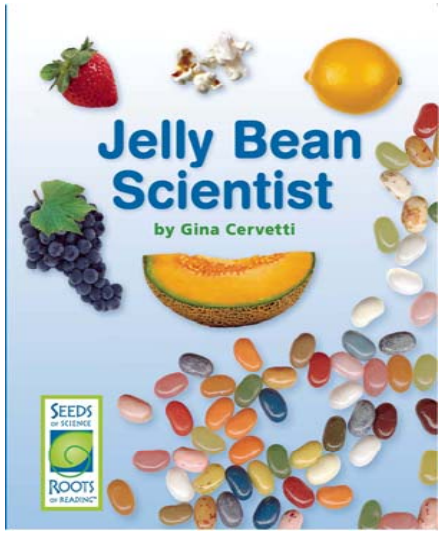
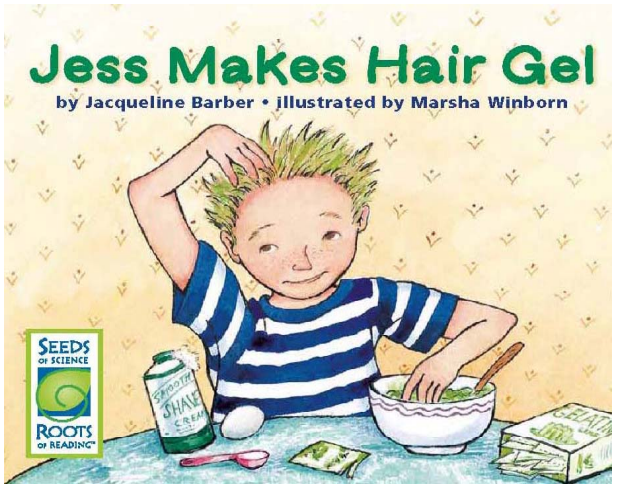
Role: Deliver Content

- Deliver science information
- Provide information and explanation about unobservable phenomena









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Summary of Roles Text in Supporting Inquiry Science

Provide Context

Deliver Content

Modeling

Supporting Second-hand Investigations

Supporting Firsthand 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
Supporting Second-hand Investigations	→	Scientists read and interpret others' data and findings
Supporting Firsthand Investigations	→	Scientists use reference books

Seeds and Roots model of integrated science and literacy instruction:

Includes a balance of learning modalities DO-TALK-READ-WRITE

Employs reading, writing, and talk in ways that are authentic to science

Provides students (and teachers) with explicit instruction in literacy skills and strategies

D

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

Growing number of Research Results

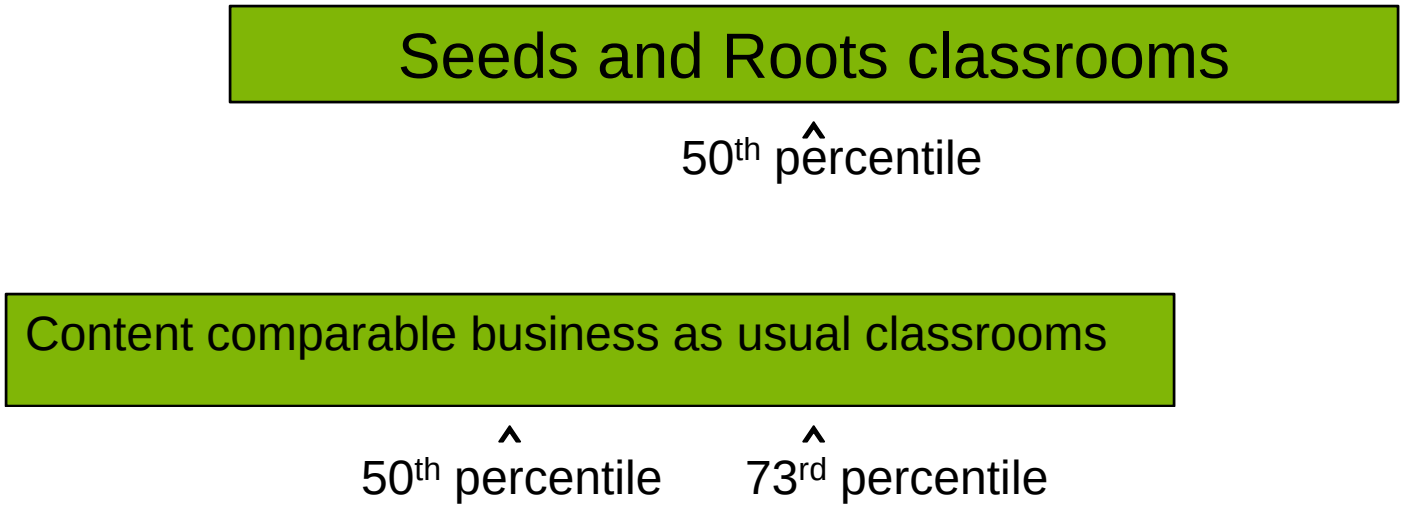
- Efficacy Studies (Joan Herman and Pete Goldschmidt of UCLA's CRESST)
  - Grades 2-3
  - Grades 3-4 (preliminary results available)
  - Grades 4-5 (still underway)
- Research Studies (Mark Girod; Western Oregon University and David Hanauer; Indiana University of Pennsylvania)

Increasing Evidence that students in SEEDS classrooms are outpacing students in content-comparable classrooms on:

- knowledge of science concepts
- knowledge of science vocabulary
- science writing
- using evidence to support explanations
- (reading comprehension)

Average Effect Size (across all studies to date)

A student in the 50th percentile of a Seeds/Roots classroom would score higher on measures of science knowledge than 73% of the students in a content comparable business as usual classroom. This is equivalent to an effect size of .61.



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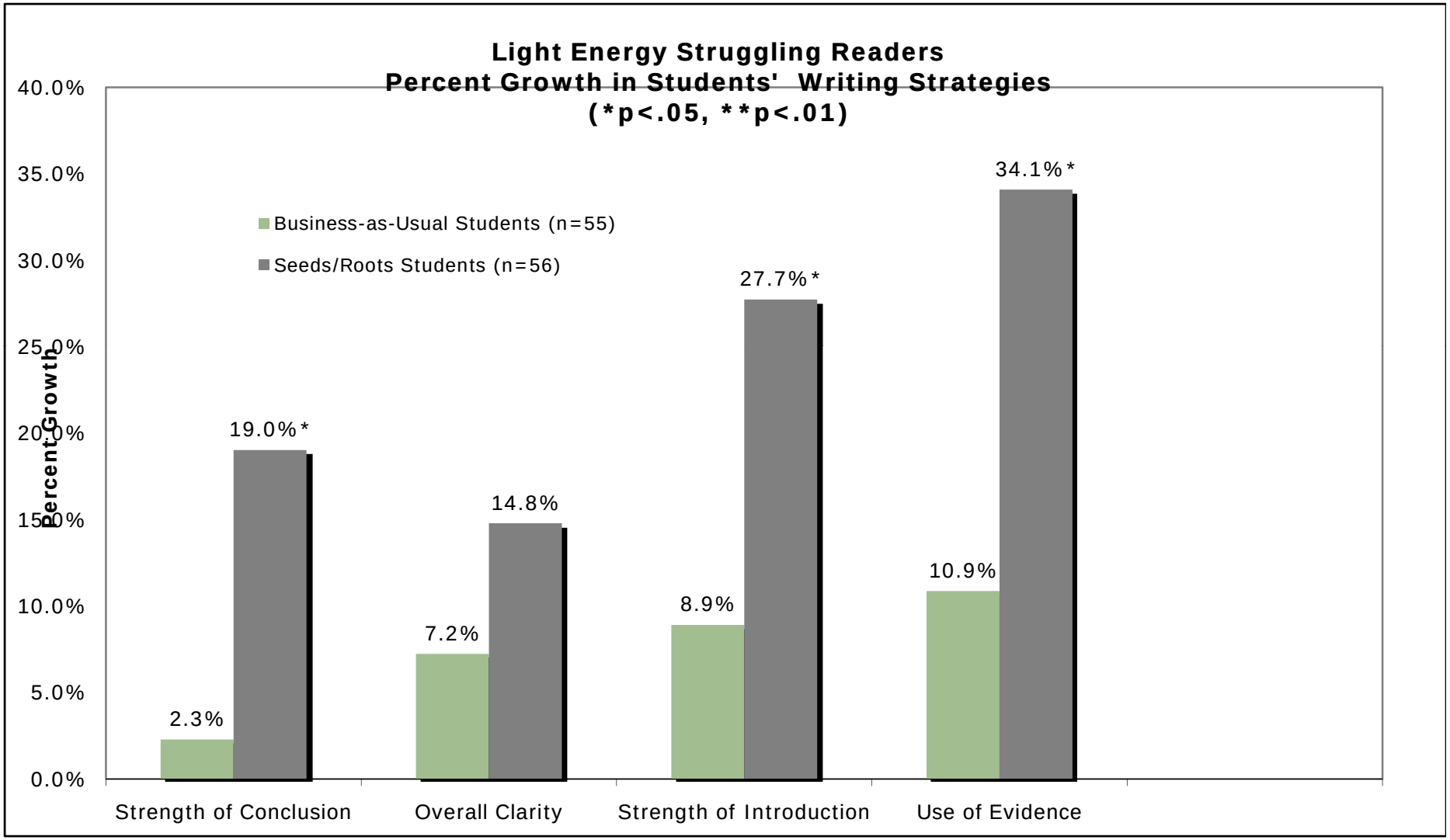
Effective for students at both ends of the Achievement Continuum

- 1/3 of the classrooms in the Grade 2-3 efficacy study had 30% or more English language learners
- For both Grade 2-3 units in the study, students who scored lowest on pre-tests made comparably-sized gains as students who scored highest on pre-tests
- Anecdotally, teachers spoke about how ELL students in their classrooms responded very well to the integrated instruction and were engaged in reading, writing, and speaking in SEEDS units more than in other settings


Light Energy Struggling Readers
Percent Growth in Students' Writing Strategies
(*p<.05, **p<.01)
Percent Growth
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Business-as-Usual Students (n=55)
Seeds/Roots Students (n=56)
2.3%
19.0%*
7.2%
14.8%
8.9%
27.7%*
10.9%
34.1%*
Strength of Conclusion
Overall Clarity
Strength of Introduction
Use of Evidence

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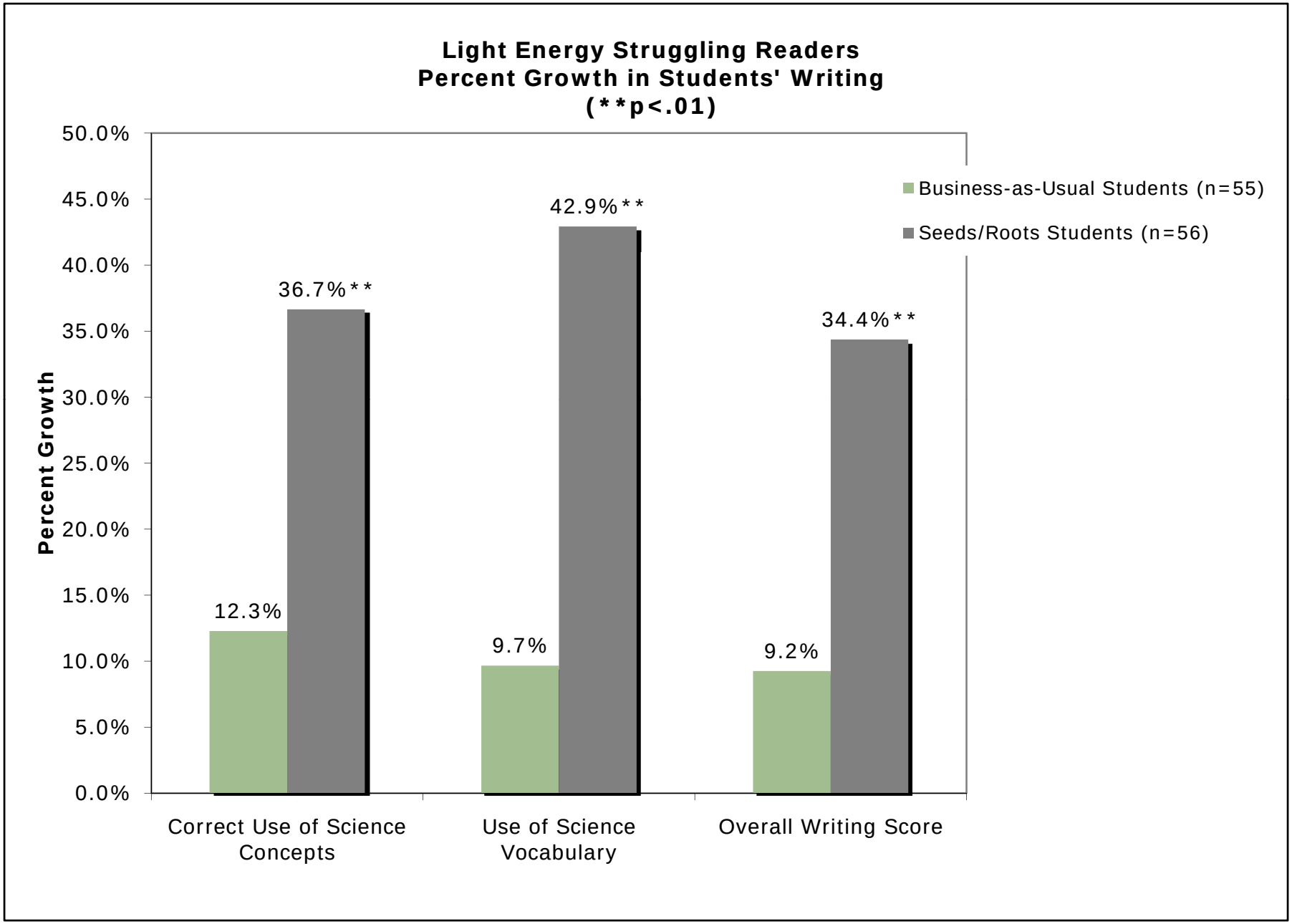
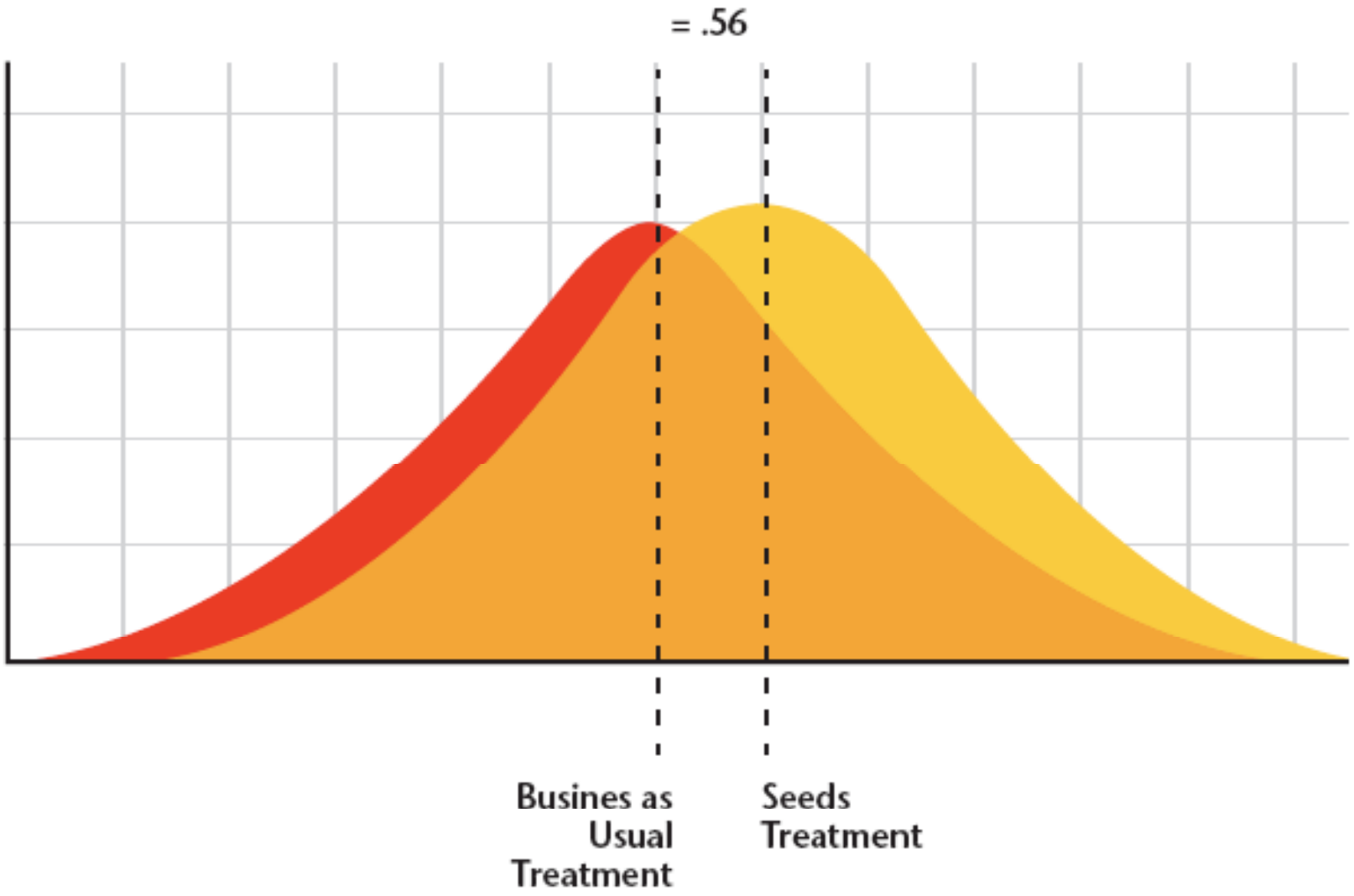

Light Energy Struggling Readers
Percent Growth in Students' Writing
(**p<.01)
Percent Growth
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
12.3%
36.7%**
9.7%
42.9%**
9.2%
34.4%**
Business-as-Usual Students (n=55)
Seeds/Roots Students (n=56)
Correct Use of Science Concepts
Use of Science Vocabulary
Overall Writing Score

D

Effect size of Seeds/Roots Curriculum for EL students
READING COMPREHENSION



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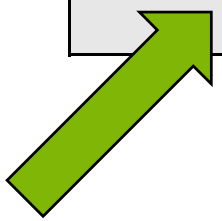
Thinking more closely about integrating content areas

Thematic	Use overarching themes to create connections among domains
Interdisciplinary	Content or processes in one domain are used to support learning in another
Integrated	Emphasis on two or more domains is balanced



Stoddart, Pinal, Latzke, and Canady; 2002

Various purposes for integrating science and literacy

1) As a better way to learn the content of science
3) To provide a context for learning and using literacy skills
3) To engage in the broader practices of science

First Purpose: As a better way to learn the content of science

- Built on the idea that students need repeated opportunities to encounter ideas
- Provide access to learning in different modalities—reading, writing, listening, speaking

Additive Integration

- Example:
  - Write a paragraph about…
  - Write a story about…
  - Read this book about…
- Provide ideas for extensions to the main body of science instruction
- Tacked on at the beginning or end of activities

Synergistic Integration

- Where students are reading, writing, listening, and speaking as part of their investigation of the natural world
- Focus on the “sweet spots” between science and literacy
- Hard to tell what is science and what is literacy

Example of additive integration of reading and science

- Students investigate with magnets
- Students read about magnets
- Students write what they learned about magnets

J

Example of synergistic integration

- Students predict what objects are attracted to a magnet and test their predictions
- Students search for evidence in text about the metal composition of the objects they tested
- Based on this new evidence, students make claims about what sticks to magnets and write explanations incorporating their claims and evidence

J

Synergy between science inquiry and reading comprehension

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	

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Example of synergistic integration—use of shared strategies

- Students make inferences based on evidence they find:
  - In firsthand observations
  - In text
- Students reflect on this powerful thinking strategy and how its use is similar and different when used in different contexts

Additive versus Synergistic Integration

Additive

Synergistic

Second Purpose: To provide a context for learning and using literacy skills

- Built on the idea that students need opportunities to use literacy skills for real purposes
- Language and literacy are tools for learning about something

Inauthentic versus Authentic integration of literacy

Inauthentic

Write a story of a raindrop as it falls from the sky.

Authentic

Write your forecast for next week's weather using evidence from this weather map to support your claim

J

Third Purpose: To engage students in the broader practices of science

- Built on the idea that different domains encompass different ways of reading, writing, listening and speaking
- Reading, writing and talking like scientists do is essential to “knowing science”
- These are practices that are part of science and need to be learned

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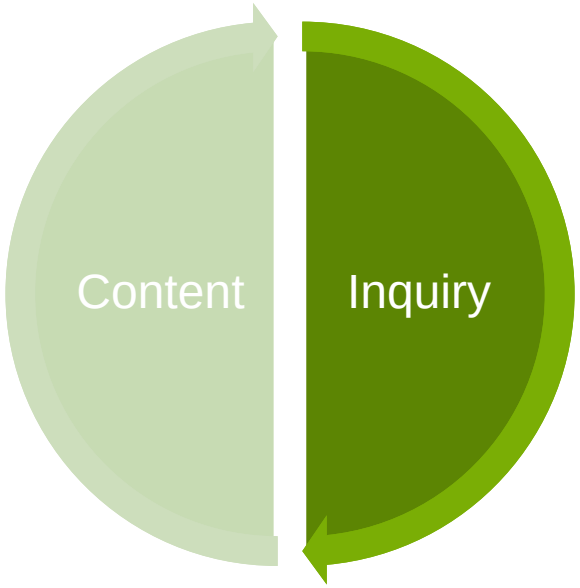
From the science perspective:

1940’s to 1960’s



1970’s to 1990’s

2000 to present

Disciplinary Literacies?

The literacy skills students need to be successful in learning in a subject matter discipline

- ✓ Science vocabulary
- ✓ Kinds of text features
- ✓ Ways of reading
- ✓ Structure of information
- ✓ What kind of evidence is privileged

Supported by NRC report

Taking Science to School (NRC: 2007) redefines what science proficiency is from just a view on content and inquiry to one that encompasses the broader practices of science including:

- ✓ Science as a way of doing, thinking, talking, reading, and writing
- ✓ Understanding the nature and development of scientific knowledge
- ✓ Knowing the norms for presenting scientific arguments and evidence

J

Lots of evidence from the literacy perspective as well

- Carnegie Council on Advancing Adolescent Literacy (2009)
- Lee & Spratley (2010)
- National Governors Association (2006)
- Graham and Perin (2007)
- Short and Fitzsimmons (2007)
- Shanahan and Shanahan (2008)
- Snow and Biancarosa (2003, 2004)

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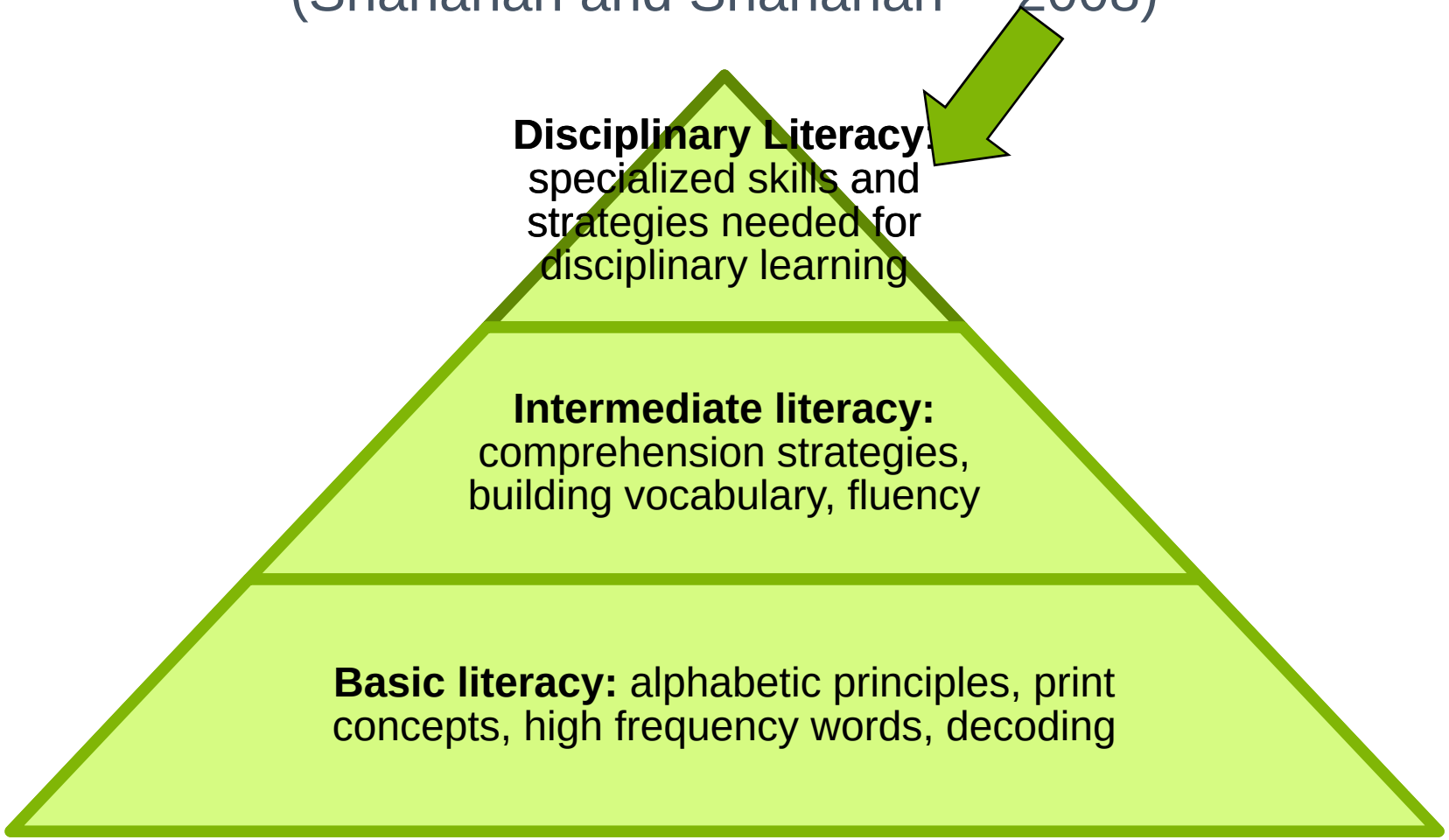
Disciplinary Literacy:

(Shanahan and Shanahan —2008)



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Are Disciplinary Literacy Skills Assumed or Taught?

Provide Practice

- Many activities in content area learning assume that students know the literacies that are specific to the domain:
  - Reading science text
  - Writing science text
  - Participating in science talk
  - Interpreting visual representations

and provide only opportunities for practice

Are Disciplinary Literacy Skills Assumed or Taught?

Provide Explicit Instruction and Practice

- Activities which provide:
  - explicit instruction,
  - scaffolded opportunities to practice, and
  - gradual release of responsibility to students

prepare all students for success in the domain

Are Disciplinary Literacy Skills Assumed or Taught?

Provide Practice

Provide Explicit Instruction and Practice

J

Seeds/Roots approach to science and literacy integration

Synergistic!

Authentic!

Explicit instruction as well as practice in using disciplinary literacy skills

J

Growing Seeds/Roots to meet the Needs of Middle Schoolers

- Greater sophistication of content
- Greater range of student abilities and prior knowledge
- Decreased motivation and engagement
- Increased importance of peers
- Increased need for choice

Design of Units

Elementary

Week 1	Week 2	Week 3	Week 4

Do, Talk, Read, Write →

Middle School

Whole Class Community

Student Projects

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6

Do, Talk, Read, Write → Apply →

TEXT SETS

Elementary

One book per week: individual and partner reading

Week 1	Week 2	Week 3	Week 4
1 book	1 book	1 book	1 book

+ 1 reference book

Systematic introduction and use of vocabulary in texts

Increasing lexical and conceptual difficulty →

Middle School

Many short texts: shared texts as well as student choice for individual/group reading + 1 reference book

Texts vary ↑

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
10-20 readings	10-20 readings	10-20 readings	10-20 readings	?	?

Systematic introduction and use of vocabulary in texts

Increasing lexical and conceptual difficulty →

TEXT ROLES

TEXT ROLE	**Elementary Examples**	**Middle School Examples**
Set context	*What if Rain Boots Were Made of Paper?*	
Provide content	*Handbook of Interesting Ingredients*	
Model Processes/Products/Dispositions	*Jess Makes Hair Gel*	
Support Firsthand Investigations	*Handbook of Interesting Ingredients*	
Support Secondhand Investigations	*Jess Makes Hair Gel*	

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TEXT ROLES

TEXT ROLE	Elementary Examples	Middle School Examples
Set context	*What if Rain Boots Were Made of Paper?*	Connects content to everyday
Provide content	*Handbook of Interesting Ingredients*	Field guide
Model Processes/Products/Dispositions	*Jess Makes Hair Gel*	Scientists profile; Research brief
Support Firsthand Investigations	*Handbook of Interesting Ingredients*	Reference book
Support Secondhand Investigations	*Jess Makes Hair Gel*	Primary source documents

TEXT ROLES

TEXT ROLE	**Elementary Examples**	**Middle School Examples**
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Support Secondhand Investigations	*Jess Makes Hair Gel*	Primary source documents
Stimulate Critique/Debate		Newspaper article

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TYPES OF TEXTS
Authenticity Gradient

Most Authentic (to science)
Science texts that are used and/or created by scientists
Science texts encountered in life
Science texts encountered in secondary school settings
Texts that are not authentic science texts but can engage/motivate readers and/or fulfill specific curricular goals
Least Authentic (to science)

Seeds of Science/Roots of Reading
Follow our progress!

scienceandliteracy.org