Integrating Literacy and Science Instruction in High School Biology:

Impact on Teacher Practice, Student Engagement, and Student Achievement

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Agenda for Today’s Talk

- Study Overview
- The Reading Apprenticeship Framework and Professional Development Intervention
- Research Design
- Study Results
- Implications
Study Overview

- Intervention (Reading Apprenticeship PD) to integrate literacy instruction into biology through collaborative, metacognitive inquiry
- Attempted to build and measure science teachers’ implementation integrating literacy and content
- Targeted schools serving African American, Latino, English Learner, and Low SES students
- Investigated the effects on student learning in both literacy and content
Science teaching is at its best when it is most like an apprenticeship.

J. Robert Oppenheimer, 1947
All Literacies are Situated, Sociocultural Practices

- Literacy is a social, cultural, and cognitive activity shaped by situation and context of use (e.g. Scribner & Cole, 1983)
- Diversity is the norm; interpretive practices vary across communities and disciplines (e.g. Heath, 1983; Lee, 1995; Lee & Spratley, 2009; Moje, 2009; Osborne, 2002)
Literacy Apprenticeships Shape Student Literacy Practices

- Students develop theories about literacy practices and purposes based on experiences (e.g. Hull & Rose, 1989; Schoenbach & Greenleaf, 2009)
- Cognitive apprenticeship makes thinking visible and helps students develop needed tools (e.g. Lee, 1995; Rogoff, 1989; Taylor, Peterson, Pearson & Rodriguez, 2002)
Social Processes Mediate Engagement, Learning and Identity

- Advanced psychological processes are acquired through socially and culturally mediated activity (Vygotsky, 1978)
- Adolescents need collaborative, social support to develop dispositions for approaching and engaging in challenging tasks (Dweck & Molden, 2005; Yore, 2004)
- Literacy development involves helping students form new identities as capable readers and learners (Gee, 1996; Mahiri & Godley, 1998).
think about the student who is having difficulty in a certain subject area not as one who is dumb or lacking in aptitude, but rather as someone standing outside of the conventions, rituals, and expectations of discourse in that field—all of which are second nature to the specialist but to a newcomer can be undecipherable.

Metacognitive Conversation draws on what science teachers know and do as experienced readers of science, and on adolescents’ underestimated strengths as learners.

<table>
<thead>
<tr>
<th>SOCIAL DIMENSION</th>
<th>PERSONAL DIMENSION</th>
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<tbody>
<tr>
<td>Creating safety to support collaborative problem solving in science &amp; reading</td>
<td>Developing science reader identity</td>
</tr>
<tr>
<td>Investigating relationships between literacy, science learning and power</td>
<td>Developing metacognition in science reading</td>
</tr>
<tr>
<td>Sharing science-related book talk</td>
<td>Developing fluency and stamina for science reading</td>
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<tr>
<td>Sharing science reading processes, problems, and solutions</td>
<td>Developing confidence with a range of written science materials</td>
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<tr>
<td>Noticing and appropriating others’ ways of reading in science</td>
<td>Assessing science reading performance and setting goals</td>
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<tr>
<th>COGNITIVE DIMENSION</th>
<th>KNOWLEDGE-BUILDING DIMENSION</th>
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<tr>
<td>Getting the big picture</td>
<td>Mobilizing and building on prior science knowledge structures</td>
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<tr>
<td>Breaking down science reading</td>
<td>Developing science knowledge</td>
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<tr>
<td>Monitoring comprehension with written science materials</td>
<td>Developing knowledge of science vocabulary</td>
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<tr>
<td>Using science-specific problem-solving strategies to assist and restore comprehension</td>
<td>Developing knowledge and use of the text structures of science curriculum materials</td>
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<td>Setting science-specific reading purposes and adjusting reading processes</td>
<td>Developing scientific discourse</td>
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<td>Developing scientific reasoning</td>
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The Reading Apprenticeship Framework

Metacognitive routines make normally invisible science reasoning processes visible and available for assessment, modeling, and coaching during science reading, problem solving, and science investigations.

**SOCIAL DIMENSION**
- Creating safety to support collaborative problem solving in science & reading
- Investigating relationships between literacy, science learning and power
- Sharing science-related book talk
- Sharing science reading processes, problems, and solutions
- Noticing and appropriating others' ways of reading in science

**PERSONAL DIMENSION**
- Developing science reader identity
- Developing metacognition in science reading
- Developing fluency and stamina for science reading
- Developing confidence with a range of written science materials
- Assessing science reading performance and setting goals

**COGNITIVE DIMENSION**
- Getting the big picture
- Breaking down science reading
- Monitoring comprehension with written science materials
- Using science-specific problem-solving strategies to assist and restore comprehension
- Setting science-specific reading purposes and adjusting reading processes

**KNOWLEDGE-BUILDING DIMENSION**
- Mobilizing and building on prior science knowledge structures
- Developing science knowledge
- Developing knowledge of science vocabulary
- Developing knowledge and use of the text structures of science curriculum materials
- Developing scientific discourse
- Developing scientific reasoning
# Reading Apprenticeship Professional Development in Biology - Intervention

## 5 Day Professional Development Institute
Integrating Literacy Routines into Biology Content
- Rich biology text sets
- Science investigations
- Cell biology, evolution and genetics
- Metacognitive Routines
- Comprehension Strategies
- Classroom Videos
- Student Case Studies

## Ongoing Support
- 5 Additional institute days
  - 2 in February, 2006
  - 3 in August, 2006
- Curriculum embedded reading assessment
- Classroom libraries linked to biology curriculum
- List serve with professional community and ongoing mentoring from RA coach

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[WestEd Logo]
Hypotheses

Intervention: Professional Development in Reading Apprenticeship

Increased Teacher Knowledge and Classroom Practice Integrating Biology and Literacy Teaching

Increased Student Engagement and Achievement in Biology and Literacy
Cluster-randomized experimental design

- 105 Biology teachers in 51 districts and 83 schools in California recruited.
- **Schools** randomly assigned to experimental and control groups.
- Professional development integrating literacy and biology for experimental group, wait-listed control.
## Data Sample

<table>
<thead>
<tr>
<th>ELA CST</th>
<th>Longitudinal Data Sample</th>
<th>Cross Sectional Data Sample</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td>Schools</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Teachers</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Students</td>
<td>832</td>
<td>404</td>
</tr>
</tbody>
</table>

More representative and balanced sample obtained in the cross-sectional sample; the cross sectional data provides the best estimate of impact of the intervention.
Teacher Survey
(Experimental/Control Differences)

Reading Opportunity-Text
Reading Opportunity-Structure
Reading Opportunity-Content
Collaboration-Modeling
Collaboration-Student Practice
Metacognitive Inquiry-Modeling
Metacognitive Inquiry-Student Practice
Comprehension Strategies - Modeling
Comprehension Strategies-Student Practice
Negotiating Success-Instruction
Negotiating Success-Assessment
Teaching Philosophy-Reading
Teaching Philosophy-Learning
Teaching Philosophy-Diversity

Difference in SD Units

* p < 0.05
** p < 0.01
Teaching Assignments (Experimental/Control Differences)

- Content
  - Cell Biology
  - Genetics
- Literacy
- Support for Cognitive Challenge

Goals
Cognitive Challenge
Support for Cognitive Challenge

* p < 0.05
** p < 0.01
Teacher Interviews (Experimental/Control Differences)

- **Reading Opportunities**: 0.25 SD units
- **Support for Student Reading Engagement**: 1 SD units
- **Metacognitive Inquiry**: 1.25 SD units
- **Reading Comprehension Routines**: 1 SD units
- **Collaboration**: 1.5 SD units

Note: * indicates significance at p < .05; ** indicates significance at p < .01.
Student Opportunity to Learn Surveys (Experimental/Control Differences)

- Reading in Biology
- Integration of Biology & Literacy
- Identifying as a Reader
- Student Identity
- Motivation in Class
- Reading Science

Difference in SD Units
Student Opportunity to Learn Surveys (Experimental/Control Differences)

- Reading in Biology
- Integration of Reading & Biology
- Identifying as a Reader
- Student Identity
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Graph showing differences in SD units for various categories with English and Non-English comparisons.
Student State Standardized Test Scores (Treatment/Control Differences)

<table>
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<tr>
<th></th>
<th>Cross-sectional</th>
<th>Longitudinal</th>
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<tbody>
<tr>
<td></td>
<td>N = 5436</td>
<td>N = 1236</td>
</tr>
<tr>
<td><strong>ES=.23</strong></td>
<td><strong>ES=.24</strong></td>
<td><strong>ES=.28</strong></td>
</tr>
<tr>
<td>ELA CST</td>
<td>**</td>
<td>**</td>
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<tr>
<td>Reading Comprehension</td>
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We Can Improve Instructional Quality through Professional Development

- Multiple measures (Teacher Surveys, Teaching Assignments, and Teacher Interviews) indicate:
  - Increased teacher support for reading engagement
  - Less lecture
  - More collaborative group work
  - More discussion of science readings
  - More metacognitive inquiry
  - More modeling and guided practice in comprehension routines and strategies
These Changes Can Result in Improved Student Learning Outcomes

- **Student Opportunity to Learn Surveys**
  - Increased reading in biology
  - Increased integration of biology and literacy
  - Increased confidence and student identity for language diverse students

- **State Standardized Test Scores**
  - Increased scores on state standardized measures of ELA, reading comprehension, and biology
For more info..

• See the research tab on the WestEd website: www.wested.org


• See a video clip of a high school science classroom implementing Reading Apprenticeship at: http://www.wested.org/readingapprenticeship