Teacher’s Voices:
How “Educative” Curriculum Materials Help Me Teach for Understanding

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NABT Professional Development Conference
5 November 2010
Project PRIME

- Promoting Reform through Instructional Materials that Educate

- Collaborative project with the Center for Research and Evaluation at BSCS and the Center for Science Teaching and Learning at NAU

- Funded by NSF in 2005 through the Teacher Professional Continuum (TPC) program

- Goal: Study impact of educative curriculum materials on teacher understanding and practice
Focus of this Session

Describe the project while highlighting the experience of the teachers in their own words
<table>
<thead>
<tr>
<th>Year</th>
<th>Dates</th>
<th>Major Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apr 05-06</td>
<td>Curriculum review by University of Michigan team&lt;br&gt;Recruit Cohort A&lt;br&gt;Using AIM process to choose between&lt;br&gt;<strong>EDC Insights on Biology or BSCS Biology: A Human Approach</strong></td>
</tr>
<tr>
<td>2</td>
<td>Apr 06-07</td>
<td>Cohort A&lt;br&gt;• Summer 1 PD (2 weeks)&lt;br&gt;• 1st year of implementation&lt;br&gt;• ASTA meeting&lt;br&gt;• 2 Collaborative Lesson Studies</td>
</tr>
<tr>
<td>3</td>
<td>Apr 07-08</td>
<td>Cohort A&lt;br&gt;• Summer 2 PD (3 weeks)&lt;br&gt;• 2nd year of implementation&lt;br&gt;• ASTA meeting&lt;br&gt;• 3 Collaborative Lesson Studies</td>
</tr>
<tr>
<td>4</td>
<td>Apr 08-09</td>
<td>Optional 3rd year of participation</td>
</tr>
<tr>
<td>5</td>
<td>Apr 09-10</td>
<td>Optional 3rd year of participation</td>
</tr>
</tbody>
</table>
### PRIME Time Line

#### Time line for Cohort 1

<table>
<thead>
<tr>
<th>Spring 05</th>
<th>Summer 06 (2 wks)</th>
<th>School Year 06-07</th>
<th>Summer 07 (3 wks)</th>
<th>School Year 07-08</th>
</tr>
</thead>
</table>

#### Time line for Cohort 2

<table>
<thead>
<tr>
<th>Spring 07</th>
<th>Summer 07 (2 wks)</th>
<th>School Year 07-08</th>
<th>Summer 08 (3 wks)</th>
<th>School Year 08-09</th>
</tr>
</thead>
</table>

**40 HS biology teachers in Arizona**
Major Components of the Project from a Participant Perspective

1. Curriculum selection process
2. Emphasis on educative curriculum materials
3. Extensive summer professional development program
4. Collaborative lesson study sessions
5. Research on Pedagogical Content Knowledge (PCK)
Component 1:
Curriculum Selection Process

- Teachers participated in a 2-day professional development experience to choose between two biology programs rated as “highly educative” by an external group.
- Teachers from the same school had to reach consensus.
Selection process included looking for evidence of Coherence and Focus

1. Coherence
   - An organizational structure that deliberately promotes student understanding,
   - Explicit links between facts and concepts that will facilitate the retrieval and application of those facts
   - Builds from and extends concepts previously developed
   - Explicit connections between the key concepts and an overarching framework about biology

2. Focus
   - Inclusion of a limited number of key concepts
   - Development of concepts in-depth at an appropriate level for an introductory college course
   - Intellectual requirement that the reader apply and demonstrate their understanding in multiple ways
   - Articulated text that helps the reader build from and extend concepts that were developed previously
• How did choosing a curriculum using the AIM process differ from other processes for choosing curriculum materials?
Educative curriculum materials are those that promote *teacher learning* as well as student learning.

(Ball & Cohen, 1996; Davis & Krajcik, 2005)

See this link: [http://www.bscs.org/pdf/prensentationhighschoolbiotext06.pdf](http://www.bscs.org/pdf/prensentationhighschoolbiotext06.pdf) for a summary of the review of biology curriculum materials.
We hypothesize that thoughtfully designed instructional materials can help teachers develop:

**Content Knowledge** – e.g., content information in the teacher materials

**Pedagogical Knowledge** – e.g., support materials for using the instructional model

**Contextual Knowledge** – e.g., information on common student misconceptions and related strategies
Teachers’ Voices

• As you learned more about BSCS Biology: A Human Approach during professional development and used it to teach all year, how do you think it was the same or different from other textbooks/approaches you had used?
Component 3: Extensive Summer Professional Development Program

Program Selection

1 week

Y1

Curriculum Analysis

Analyze Units a,b

2 weeks

Teach a

ASTA and 2 Lesson Study Cycles

Fall
Analyze
Student Work
Plan y

ASTA

Teach b

Spring
Analyze
Student Work

Curriculum Analysis

Analyze Units c,d,e

3 weeks

Teach c

ASTA and 3 Lesson Study Cycles

Fall
Analyze
Student Work
Plan d

Teach d

ASTA

Teach e

Winter
Analyze
Student Work
Plan e

Spring
Analyze
Student Work
Some PD Features

• Participants switched between a teacher hat and a student hat.
• There was an emphasis on understanding the curriculum features that supported student understanding of concepts as well as an emphasis on the educative features of the curriculum and teacher craft knowledge.
• Participants taught selected activities to their colleagues.
• There was one content deepening experience per unit – usually a university researcher describing his/her research; later participants work to make connections between the lecture and the curriculum.
A PD Example: Understanding Concept Development in Curriculum

1. On a sticky note, write a sentence for the **one** big idea or concept addressed in each of your activities. It should be a **complete sentence** that describes a relationship between/among ideas.

2. Compare your big idea sentences with the other members of your **Expert** group and come to consensus on one sentence that best expresses the concept addressed in each of your activities.

3. Each member of the **Expert** group should write the consensus sentence on a sticky note to take back to his/her **Home** group.
4. Return to your Home group.
5. Share the major concept in each activity of the chapter.
6. Work together to write a sentence that conveys the overarching concept of the chapter. Write this sentence on a sticky note.
7. Talk with each other about:
   a) How the concepts in your section build from those in previous sections
   b) How concepts in your section are extended in subsequent sections
   c) How the concepts in your section connect to the overarching concept of the chapter
   d) The context in which the concepts are presented
Chapter 9

Matter and Energy in Ecosystems

Muscles are organized into simple and complex structures.

Strong and weak bonds.

Food and activity levels are related to performance.

Chapter 7

Chapter 8

Chapter 9

Carolyn, Eric, Michele.
1. Work with a partner to discuss how you, as an adult, define the terms “matter” and “energy.”
2. Review several student journals and study how students define these terms at this point in the year.
3. Create two Venn diagrams comparing the adult and student definitions of “matter” and “energy.”
4. Hang your poster in the room.
5. Share your analysis with the class.

SB, pages 289 – 293
Teachers’ Voices

• What was your reaction to the development of Conceptual Flow Graphics?
• How did the CFGs affect your decisions when you were teaching?
• What do you remember most about the summer PD experiences?
Component 4: Collaborative Lesson Study Sessions

- Participants worked in small groups to choose one lesson that they agreed to teach in a similar way, video record, and collect student work from.
- Planning was done during the summer.
- CLS sessions were held twice during each school year.
<table>
<thead>
<tr>
<th>Program Name: AHA</th>
<th>Unit Name and Number: Ecology: Interaction and Interdependence in Living Systems Unit 6</th>
<th>Activity Name: Critters and Interdependence</th>
</tr>
</thead>
</table>

Focus Question: What will student work based on their critters in the form of a story suggest about their understanding of resources, carrying capacity, growth rate, and limiting factors?

Expected Student Learning Outcomes

1. By the end of this activity the learners should demonstrate their understanding of the following concepts; resources, carrying capacity, growth rate, and limiting factors by making these concepts an integral part of their story.

Ways that students can communicate understanding of the concept(s)…

Students will demonstrate their understanding of the concepts of resources, carrying capacity, growth rate, and limiting factors by writing a story that includes illustrations about their critters and the interactions between their critters and that of others in the same environment.

Connecting to the Conceptual Flow Graphic: How should this activity contribute to students’ understanding of the overarching concept of the unit? In this chapter students where engaged in an activity where they directly observed organisms interacting in their natural environment, then explored the interactions between these organisms. Next students explained how limited resources and the carrying capacity of a simulated commons pasture affected cattle populations and financial profit. Then students elaborated on these concepts by studying a case study about the population changes that occurred historically on Easter Island. Finally students write a story based on their critters interacting in a particular environment with other critters to show their understanding about the concepts of resources, carrying capacity, growth rate, and limiting factors. This story serves as a way to evaluate student understanding of the concepts previously stated.
# Rubric: Critters and Interdependence

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Excellent</th>
<th>Could Be Improved</th>
<th>Needs Substantial Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept:</strong> Showing understanding of the big picture in this chapter</td>
<td>Story describes the interdependence and interactions between the organisms that inhabit this ecosystem, using specific examples that clearly show the author’s understanding that those interactions are complex and essential.</td>
<td>Story generally describes the interdependence and interactions between the organisms that inhabit this ecosystem, showing the author has a general understanding that those interactions are important.</td>
<td>Short story describes the interdependence and interactions between the organisms that inhabit this ecosystem without, or incorrectly explaining, the essential interactions.</td>
</tr>
<tr>
<td><strong>Explanation:</strong> Explanation for population growth trends, including specific evidence to support ideas</td>
<td>Description of the critter’s population growth includes an explanation of what type of growth it is, using correct terminology and a specific example for comparison.</td>
<td>Description of the critter’s population growth includes a general explanation of what type of growth it is, using some terminology and examples.</td>
<td>Description of the critter’s population growth lacks an explanation of, or gives an incorrect explanation for, what type of growth it is.</td>
</tr>
<tr>
<td></td>
<td>Story gives 4 or more specific examples that explain how the populations of organisms are likely to change as a result of their interactions with the environment in their habitat.</td>
<td>Story gives 2 or 3 examples that explain how the populations of organisms are likely to change as a result of their interactions with the environment in their habitat.</td>
<td>One or no examples are used to explain how the populations of organisms are likely to change as a result of their interactions with the environment in their habitat, or the examples used are inappropriate.</td>
</tr>
<tr>
<td><strong>Explanation:</strong> Explanation for how limiting factors and carrying capacity affect population size, including specific evidence to support ideas</td>
<td>Story correctly identifies at least 5 limiting factors present in the environment and explains their impact clearly and accurately.</td>
<td>Story generally identifies 3 or 4 limiting factors present in the environment and explains their impact.</td>
<td>Story shows little evidence that the author understands limiting factors or carrying capacity.</td>
</tr>
<tr>
<td></td>
<td>Story provides specific information about the carrying capacity of the environment and how it might change in response to changes in the environment, for example, in response to limiting factors.</td>
<td>Story provides general information about the carrying capacity of the environment and how it might change in response to changes in the environment. Some descriptions of limiting factors or the influence of carrying capacity are incorrect.</td>
<td>Story includes few or incorrect references to the impact that limiting factors have on carrying capacity.</td>
</tr>
<tr>
<td><strong>Creativity</strong></td>
<td>Story includes interesting, appropriate, and engaging information about author's critter as well as classmates' critters that are living in the same ecosystem.</td>
<td>Story includes basic information about author's critter and classmates' critters that are living in the same ecosystem.</td>
<td>Story does not demonstrate much time or effort on the author’s part—few details were imagined or thoroughly described.</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td>Drawings, diagrams, and descriptions make it easy for any reader to imagine how this critter experiences interactions and interdependence in its habitat. Grammar and punctuation are used correctly, making it easy to understand what was meant.</td>
<td>Drawings, diagrams, and/or descriptions give the reader a general idea of how this critter experiences interactions and interdependence in its habitat. Grammar and punctuation are generally used correctly. Sometimes it is difficult to be sure what was meant.</td>
<td>Drawings, diagrams, and/or descriptions were done too hastily to include the descriptions necessary to give readers a clear idea of how this critter experiences interactions and interdependence in its habitat.</td>
</tr>
</tbody>
</table>
I. Whole Group Preparation
   – Review process for the day to include team assignments, room locations, equipment access
   – Review norms of participation
   – Questions

II. Small Group Discussions

<table>
<thead>
<tr>
<th>Time</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>Small Group Preparation</td>
</tr>
<tr>
<td>15 min</td>
<td>Lesson Overview</td>
</tr>
<tr>
<td>5 min</td>
<td>Clarifying Questions</td>
</tr>
<tr>
<td>10 min</td>
<td>Read Student Work</td>
</tr>
<tr>
<td>10 min</td>
<td>Probing Questions</td>
</tr>
</tbody>
</table>
CLS Discussion Protocol

II. Small Group Discussions, continued

<table>
<thead>
<tr>
<th>Time</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 min</td>
<td>Pause to Reflect</td>
</tr>
<tr>
<td>10 min</td>
<td>Share Feedback</td>
</tr>
<tr>
<td>15 min</td>
<td>Presenter’s Response to Feedback</td>
</tr>
<tr>
<td>10 min</td>
<td>Summary and Next Steps</td>
</tr>
</tbody>
</table>

Total time = 83 minutes

III. Whole Group Debrief

– What did you learn from this experience?
– General discussion of the tuning protocol may develop.
– Discuss frustrations, misunderstandings, positive reactions participants may have experienced.
• Of what value were the school year sessions when you shared video and student work with other teachers?
• What was the value of jointly planning that lesson during the summer PD?
• How could this experience have been richer and more rewarding?
Component 5: Research on PCK

Research Questions
1. How does a teacher’s Pedagogical Content Knowledge change
   – With the use of highly educative curriculum materials?
   – With or without professional development?

2. How does teacher knowledge correlate to student achievement?

3. What is the relationship between PCK and fidelity of use of highly educative materials?
Measurements

1. PCK Reflections (CK, PK, CxK, PCK)
2. Structured Interviews (CK, PK, CxK, PCK)
3. Videotapes of Classroom Instruction (CK, PK, CxK, PCK, Fidelity of Implementation)
4. Major Field Test for Biology (ETS) (CK)
5. Reform Teaching Observation Protocol (CK, PK, CxK)
6. Student Achievement
7. Student Work
Data Collection Schedule

- **BL**: Baseline, prior to program start
- **PD**: Following summer professional development
- **PDT**: Following professional development and teaching the topic once
- **T**: Following teaching without professional development
- **TPD**: Teaching followed by professional development
- **PDTT**: Following professional development and teaching the topic twice
- **TPDT**: Teaching in year 1, followed by professional development and teaching in year 2.
## Analysis

<table>
<thead>
<tr>
<th>Student achievement</th>
<th>Gain scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher content knowledge</td>
<td>T-test</td>
</tr>
<tr>
<td>Fidelity of Implementation (FOI) scoring rubric</td>
<td>Descriptive statistics</td>
</tr>
<tr>
<td>PCK reflections</td>
<td></td>
</tr>
<tr>
<td>Student achievement</td>
<td>Correlations</td>
</tr>
<tr>
<td>Teacher content knowledge</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relationships between</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aggregate teacher-level variables and student post-test</td>
<td>Hierarchical Linear Modeling</td>
</tr>
<tr>
<td>• Subcategory of FOI and student post-test</td>
<td></td>
</tr>
<tr>
<td>Relationship between PCK components and FOI (and reverse)</td>
<td>Ordinary Least Squares Regression</td>
</tr>
</tbody>
</table>
Teachers’ Voices

• What do you remember most about the research component of the project?
• How did participating in Project PRIME change you as a teacher?
What We’ve Learned

The Researchers’ Perspective

• Teachers matter!
• We need more classroom-based research.
• Life events can have a significant impact on multiple year studies.
• We need districts who are willing to commit to longer-term projects.
The Participants’ Perspective

- Participating in the project offered a sense of community
- Eye-opening to be part of a study
- Part of something bigger
- Levels of study kept it interesting (researchers → teachers → students)
- Learned from other teachers (including the researchers)
- Inquiry-based learning is best for students and very possible to implement
- Educative materials have stronger assessment options
Thank you!

Slides will be available at

www.bscs.org/sessions

by Monday

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