4-3-2013

Educative Supports for Teachers in Middle School Mathematics Curriculum Materials: What is Offered and How is It Expressed?

Lorraine Males

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Abstract for DBER Group Discussion on 2013-04-04

Presenter, Department(s):
Lorraine Males
Department of Teaching, Learning, and Teacher Education
University of Nebraska-Lincoln

Title:
Educative Supports for Teachers in Middle School Mathematics Curriculum Materials: What is Offered and How is It Expressed?

Abstract:
In this talk I will present the findings from my study of the educative nature of four middle school mathematics curriculum materials. Educative curriculum materials are materials for Grades K-12 that are “intended to promote teacher learning in addition to students” (Davis & Krajcik, 2005, p. 3). I particularly investigated the opportunities for teacher learning embedded within four middle school curricular series in the areas of introduction to variable and geometric transformations. Drawing on the work on educative curriculum materials from science education (Davis & Krajcik, 2005) and Systemic Functional Linguistics (Halliday, 1985), I investigated opportunities to learn by examining the content presented (i.e., subject-matter, pedagogical content, curricula) and certain aspects of the voice (i.e., use of personal pronouns, modality) of teachers’ guides. Results indicated that although all four curricular series included content supports, these supports may be insufficient. In addition, the ways in which authors spoke to teachers in the written text may further hinder teachers’ opportunities to learn. Implications for curriculum development, teacher education, and research will be discussed.
Educative Supports for Teachers in Middle School Mathematics Curriculum Materials: What is Offered and How is it Expressed?

Lorraine M. Males
Mathematics Education
Teaching, Learning, and Teacher Education
Presentation Agenda

• A Bit About Me
• Motivation & Background
• Methods
• Results
• Discussion & Next Steps
• Questions
A Bit About Me

Bay Shore, NY ::
Where I grew up and attended K-12 [and decided I wanted to be a teacher]

Ithaca, NY ::
Received my B.S. in Mathematics & Computer Science with 7-12 Teacher Certification
Did student teaching in Ithaca and HS in Harlem

Teaching Job #1::
Moanalua High School, Honolulu, HI [Public School] 
Taught: 9-12

Teaching Job #2::
The Wilbraham & Monson Academy, Wilbraham, MA [Private Boarding]
Taught: 6-12

Teaching Job #3::
The Dwight Englewood School, Englewood, NJ [Private]
Taught: 9

Graduate Work ::
Michigan State University  
East Lansing, MI  
Ph.D., mathematics education  
2007-2011

Assistant Professor ::
UNL

Graduate Work ::
Teachers College, New York, NY  
Ed.D. Program, 1 semester

Assistant Professor ::
UNL
MOTIVATION & BACKGROUND
Why I wanted to do this study

Small World, Isn’t It?

Everyone knows that the world’s population is increasing.

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<td>5,290,000,000</td>
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<tr>
<td>1995</td>
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The Derivative

Mathematical Objectives:
- Applying the derivative to a function at a point.
- Defining the derivative.

In Class:
1. Discuss Homework 13: The Growth of the Oil Slick
2. Discuss 20/000000
   - Introduce the idea of the derivative.
   - Show that the slope of the tangent line at a point is the instantaneous rate of change.
3. Define the derivative of a function at a point.
   - Bring out the common idea that the derivative is the slope of the tangent line.
   - Introduce the term "derivative" to describe the rate of change at a point.

Discuss With Your Colleagues

From Slope Right to Derivatives

The formal concept of slope was just introduced a couple of weeks ago, and now students are talking about derivatives! Is this too big a jump? Is it reasonable to expect most eleventh graders to understand an idea that is traditionally reserved for college students? How does this “early” introduction of derivatives relate to the fact that the concept of slope is introduced “late” in the IMP curriculum?

Have spade card students present their work on different parts of the assignment. The concept of an instantaneous rate of change may be harder for students to visualize in this context than it was in the context of speed (for instance, in The Instant of Impact).

Have students sketch (by hand) a graph of the area (as a function of time) in order to get an intuitive sense of the instantaneous growth rate. Have them mark line segments on the graph to show the relevant values. For instance, the graph here indicates the segments needed to find the rate of change in the area for the time interval from $t = 0$ to $t = 2$. (A larger version of this graph, without the line segments, is included in Appendix B.)
Why the field needs this study

Teacher learning is critical to success (Cohen, Raudenbush, & Ball, 2002; Putnam & Borko, 2000), especially with the implementation of new standards, such as the Common Core Standards (Confrey, 2010; Lappan, McCallum, Kepner, 2010).

We know little about the features of written curriculum materials, let alone how these materials may impact teacher learning (Stein, Remillard, & Smith, 2007).

Curriculum materials can and do learn from using curriculum materials (Choppin, 2008; Collopy, 2003; Drake & Sherin, 2009; Lloyd, 2008; Remillard, 2000; Remillard & Bryans, 2004; Schneider, Krajcik, & Blumenfeld, 2005; Schneider & Krajcik, 2002; Schneider, 2006; Van Zoest & Bohl, 2002).
Background – Curriculum and Teachers

Figure 1: Visual representation of the variables that influence the enacted curriculum.

Factors that Influence
OFFICIAL GOALS & CURRICULUM
- E.g., Needs of society,
- Advances in mathematics, understanding of learning, technology;
- Policies, assessment practices and constraints;
- Values and beliefs about mathematics goals of education

Factors that Influence
INTENDED CURRICULUM
- E.g., knowledge, beliefs, practices, access to resources and support, knowledge of students and local context

Factors that Influence
INSTRUCTIONAL MATERIALS
- E.g., Market forces, professional societies, learning research, curricular goals, developers’ vision

Factors that Influence
ENACTED CURRICULUM
- E.g., Teacher and student knowledge, beliefs, practices, access to resources, contextual resources and constraints

Factors that Influence
STUDENT LEARNING
- E.g., Prior knowledge, identity, attitude, motivation, home support, comfort

Curricular Goals

Content of Consequential Assessments (curriculum & norm referenced)

Designated Curriculum

Teacher Intended Curriculum

Enacted Curriculum

Instructional Materials

Student Learning

Adopted
Selected
Incorporated

Official

Operational
The **teacher** plays an active role in enacting the curriculum.

“Its [the curriculum’s] primary value, its primary indication, is for the teacher, not for the child. It says to the teacher: Such and such are the capacities, the fulfillments, in truth and beauty and behavior, open to these children. Now see to it that day by day the conditions are such that their own activities move inevitably in this direction, toward such culmination of themselves. (Dewey, 1902, p. 39).”

The **curriculum** plays a role in teacher learning.

“If it (new curriculum) cannot change, move, perturb, inform teachers, it will have no effect on those they teach. It must first and foremost be a curriculum for teachers. If it has any effect on pupils, it will have it by virtue of having an effect on teachers” (Bruner, 1977, p. xv).
Educative Curriculum Materials

To be educative (serve as a source of learning for teachers), curriculum materials must:

→ be more than just a textbook for students

Content must include

→ *Enactment* Guidance

→ *Rationale* Guidance

Expression must

→ allow for the text to speak through teachers

(Ball & Cohen, 1996; Beyer et al, 2009; Li, 2004; Remillard, Watanabe, 2005)

**Enactment Guidance Example**

“In the case of tables, one has to decide which values of the independent variable should be represented in the table to give most informative results” (CMP, Variables & Patterns, p. 3).

**Rationale Guidance Example**

"Unlike the combination chart, notebook notation can be used to solve problems involving combinations of more than two kinds of items. In addition, notebook notation can be used to record the new combinations. Students should come to appreciate the advantages of notebook notation over guess-and-check strategies and combination charts" (MiC, Comparing Quantities, p. 22B).
Focus of Study - Research Questions

1. What is the relative frequency of educative supports in middle school mathematics curriculum materials for teachers’ subject matter content knowledge, pedagogical content knowledge for mathematics topics and practices, and curricular knowledge?

2. How do middle school mathematics curriculum materials speak to teachers (i.e., what language choices do they make) through the written text in the teachers’ guides?

3. How does opportunity to learn (content and expression) differ for introduction to variable and geometric transformations?
A Note about my Purpose

Curriculum Development is difficult

All of what authors intend does not always make it to the final printed page

My purpose is **NOT** to name the curriculum with the best teacher support, but to **describe opportunities to learn** and to **raise awareness** of how content and expression may influence these opportunities.
METHOD
Curricular Series

• Connected Mathematics Project (CMP)
• Math Connects (Glencoe)
• Mathematics in Context (MiC)
• Transition Mathematics (UCSMP)

Mathematical Content

• Introduction to Variable
• Geometric Transformations
Analytic Framework – Capturing Content

Support for understanding the mathematics curriculum, including how topics relate to each other and the features and philosophies of materials

Codes
- Subject-matter Content
  - E/R - Experiences
  - E - Possible Student Pitfalls

Codes
- E - Using Questions (w/sug answers)
- E - Using Questions (w/o sug answers)
- R - Questions
- E - Helping Students Ask/Answer Own ?s
- E/R - Justification, Reasoning, & Proof
- E/R - Developing Math Terminology
- E/R - Participation Structures

Codes
- E/R - Curricular Overview
- E/R - Curricular Features
- E/R - Curricular Storyline
- E/R - Curricular Goals
- R – Curricular Philosophy

Adapted from Beyer et al. (2009)
“Voice” (Herbel-Eisenmann, 2007; Morgan, 1996)
→ helps to identify “how speakers shift positions, identities, and alignments toward the words they speak as well as toward one another” (Herbel-Eisenmann, p. 347).

**Systemic Functional Linguistics** (Halliday, 1985)
→ Strata & Realizations

→ Metafunctions
  → interpersonal
  → ideational
  → textual

Martin & Rose, 2007, p. 5
Analytic Framework – Capturing Expression

Personal Pronouns
→ first person – “I” and “we”
→ second person – “you”

“You”-forms
→ implicit - imperatives
→ explicit - “you” + modal verbs

You should emphasize that the value could be found by solving an equation (UCSMP, Some Imp Geom Ideas, p. 397)

You might suggest that they imagine a point leaving a trail (CMP, KHM, p. 53)

Explain that the function rule describes the relationship between... (Glencoe, Algebra: Functions, p. 47)

"the degree of likelihood, probability, weight, or authority a speaker attaches to the utterance" (Hodge & Kress, 1993) and can be negotiated on a scale that describes "how obliged" you are to act (Martin & Rose, 2007)
Example of coded page (MiC)

Content
→ SMK
→ PCK-Topics
→ PCK-Practices
→ CK

Expression
→ imperatives
→ “you”+modal verbs
# Inter-rater Reliability - Content

<table>
<thead>
<tr>
<th>Variable</th>
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<tr>
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<tr>
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<tr>
<td>MiC</td>
<td>85</td>
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<tr>
<td>UCSMP</td>
<td>91</td>
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</tbody>
</table>
# Inter-rater Reliability - Expression

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<th>Imperatives</th>
<th>Modal Verbs</th>
<th>Transformations</th>
<th>Personal Pronouns</th>
<th>Imperatives</th>
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<td></td>
<td>100</td>
<td>96</td>
<td>100</td>
</tr>
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</table>
TOP LEVEL RESULTS
Structure of the Teachers’ Guides

Did not exist in Glencoe and UCSMP

Embedded vs. Non-embedded

---

### 1.1 Preparing for a Bicycle Tour

**Goals**
- Collect experimental data and organize it in a table.
- Identify patterns and relationships between variables using information in a table.

#### Launch 1.1

Tell the class about bicycles and the safety rules to follow across Iowa. Encourage students to share any facts about organized bicycle trips they might know. Then conclude reading about the bicycle trip that the college students are planning. Have students share their ideas about the questions in the Getting Ready student activity and add their guesses about the distance they think they would ride in a day and consider ways in which their speed might vary throughout the day.

**How long do you think you could ride a bike in one day? (Answers will vary.)**

**How fast can you ride a bicycle? (Answers will vary.)**

**What would you need to carry on a bicycle trip?**

6. Start with legs together and hands at sides.

7. From here, build on your current speed and speed-reading the road.

**The essence of the trip is just as important as the distance itself.**

8. Identify various obstacles and avoid them from the start.

**The essence of the trip is just as important as the distance itself.**

9. Identify various obstacles and avoid them from the start.

**The essence of the trip is just as important as the distance itself.**

---

**Lesson Notes**

**Focus**

- Vertical Alignment
- Before Lesson 1-1
- Learn and practice
- Lesson 1-1
- Use the space provided to note important information.

**Main Idea**

- Use the space provided to note important information.

---

**A Plan for Problem Solving**

**Launch 1-1**

- Use the space provided to note important information.

---

**Study Tip**

- Use the space provided to note important information.

---

**Additional Resources**

- Sample problem: Determined to find the number of moon craters on a nearby planet, two top astronomy students decided to count the number of its moons on their trip.
Content – Knowledge by Category

- Subject Matter Knowledge
- Pedagogical Content Knowledge for Topics
- Pedagogical Content Knowledge for Practices
- Curricular Knowledge
## Content – Type of Support (Enactment & Rationale)

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<td>99%</td>
<td>1%</td>
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<td>6%</td>
<td>98%</td>
<td>2%</td>
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<td>6%</td>
<td>97%</td>
<td>3%</td>
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<td>Content - Location of Support</td>
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<td>16%</td>
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<td>81%</td>
<td>18%</td>
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</table>
Expression – Frequencies of Pronouns

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<td>we</td>
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<td><strong>Glencoe</strong></td>
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<td>19</td>
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<td><strong>MiC</strong></td>
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<td>61</td>
</tr>
<tr>
<td><strong>UCSMP</strong></td>
<td>20</td>
<td>33</td>
</tr>
</tbody>
</table>
Expression – Use of “we”

Clear referents for “we”

“we” refers to curriculum authors

Functions:

1. Make suggestions or recommendations for teachers
   (e.g., "We recommend that...", "We encourage...")

2. State assumptions/choices without rationale
   (e.g., "We introduce...", "We ask students...", "We assume...")

3. State assumptions/ choices with rationale (e.g., "We start with tables because...", "We have purposely chosen...because")
Expression – Use of “we”

Unclear referent for “we”

“we” is used in questions or statements, particularly when outlining solutions or procedures

Some possible functions:

→ Bring authors into the community of the discipline of mathematics

→ Bring authors into the mathematical classroom community
Expression – “You”-Forms

![Bar chart showing implicit and explicit expression rates for CMP, Glencoe, MiC, and UCSMP for variables and transformations.](chart.png)
Expression – Types of Imperatives

Variable

<table>
<thead>
<tr>
<th>CMP</th>
<th>Glencoe</th>
<th>MiC</th>
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Transformations

<table>
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## Expression – Types of Imperatives

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<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Expression – Modal Verbs

![Bar chart showing the percentage distribution of low, median, and high modal verbs for CMP, Glencoe, MiC, and UCSMP in variables and transformations.](image-url)
DISCUSSION & NEXT STEPS
In general, insufficient opportunities

→ Over 15 of 31 content supports were unobserved or infrequent

→ Absent supports were often *Rationale Guidance* supports (accounted for no more than 6% of support)

→ Language often positioned teachers as agents doing the bidding of the “more knowledgable” curriculum authors
Implications – Curriculum Development

1. Raise awareness about possible impacts of content and expression

2. Speak more “to” rather than “through” teachers
   - Expression – Choose to use less imperatives and more modals verbs
   - Content – Include more rationale

3. Be more strategic about location of support
   - more (particularly SMK) at lesson level
Implications – Teacher Education

1. Recognize the important role of curriculum materials in teacher education

2. Create opportunities for teachers to work with curriculum materials
   - help with “reading” curriculum materials (including pointing out where to find support)
   - compare and critique various curriculum materials
   - plan and enact lessons from materials

3. “Teaching with rationales” – Think about being more explicit in teacher education courses
Implications – Research

1. Recognize the importance of expression in curriculum materials, not just the content

   - Seeking out new frameworks and combining them to get a more nuanced description of opportunity to learn

2. Consider how the philosophy and structure of the curriculum materials impacts analysis
Examining how teachers learn from the opportunities in written mathematics curriculum
Future Directions for Research and Development

Design and research teachers use of electronic curriculum materials
   → more support is possible
   → customizable
   → adaptable
Thank you all for attending this talk
and thank you to

I’d like to acknowledge:
Jack Smith, Glenda Lappan, Beth Herbel-Eisenmann,
Kristen Bieda, Aladar Horvath, Jillian Cavana, Joanne
Phillhower, & The Division of Science and
Mathematics Education at Michigan State University
Questions

Lorraine M. Males
Teaching, Learning, & Teacher Education
lmales2@unl.edu
Educative Supports for Teachers in Middle School Mathematics Curriculum Materials: What is Offered and How is itExpressed?

Lorraine M. Males
Mathematics Education, Department of Teaching Learning, and Teacher Education

Focus of Study and Research Questions

To describe opportunities for teacher learning embedded in written middle school mathematics curriculum materials by investigating the content of the teachers’ guides and how this content was expressed. Specifically, I address the following research questions:

1. What is the relative frequency of educative supports in middle school mathematics teachers’ guides for teachers’ subject matter content knowledge, pedagogical content knowledge for mathematics topics and practices, and curricular knowledge?
2. How are supports expressed to teachers in middle school mathematics teachers’ guides?

Data Sources

Teachers’ Guides for the Introduction to Variable and Geometric Transformations units from each of the following:
- Connected Mathematics Project 2 (Lappan, Fey, Fitzgerald, Friel, Phillips, 2006) [CMP]
- Mathematics in Context (Wisconsin Center for Education & the Freudenthal Institute, 2010) [MiC]
- UCSMP’s Transition Mathematics (Viktora, Cheung, Highstone, Capuzzi, Heeres, Metcalf, et al., 2008) [UCSMP].

Results

Content Supports

Types of Knowledge

Subject Matter PCK for Topics PCK for Practices Curricular

<table>
<thead>
<tr>
<th>Content Supports</th>
<th>Types of Knowledge</th>
<th>Variable Transformations</th>
</tr>
</thead>
<tbody>
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<td>Subject Matter</td>
<td>Enactment</td>
<td>Rationale</td>
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<tr>
<td>UCSMP</td>
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</tbody>
</table>

Expression

Aspects of “Voice” (Herbel-Eisenmann, 2007) helps to identify “how speakers shift positions, identities, and alignments toward the words they speak as well as toward one another” (Herbel-Eisenmann, 2007, p. 347). Systemic Functional Linguistics (Halliday, 1985)

Metanetworks
- interpersonal
- ideational
- textual

Martin & Rose, 2007, p. 5

Personal Pronouns
- first person – “I” and “we”
- second person – “you”

“-you”-forms
- implicit - imperatives
- explicit - “you”+ modal verbs

You should emphasize that the value could be found by solving an equation (UCSMP, Some Imp Geom Ideas, p. 397)

Support for obtaining a robust understanding of the mathematics

Support for student ideas, math-specific strategies, tools, & representations

Support for mathematical practices such as questioning, discourse practices, & reasoning and proof

Subject Matter | PCK-Topics | PCK-Practices | Curricular

<table>
<thead>
<tr>
<th>Subject Matter Content</th>
<th>Enactment Guidance</th>
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<tr>
<td>Experiences</td>
<td>Use Questions</td>
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<tr>
<td>Possible Pitfalls</td>
<td>(w/ answers)</td>
</tr>
<tr>
<td>Engage Students in</td>
<td>Help Students</td>
</tr>
<tr>
<td>Prob. Exp</td>
<td>Ask/Ans Own ?s</td>
</tr>
<tr>
<td>Act. Sequences</td>
<td>Reasoning &amp; Proof</td>
</tr>
<tr>
<td>Representations</td>
<td>Developing Math</td>
</tr>
<tr>
<td>Tools</td>
<td>Terminology</td>
</tr>
<tr>
<td>Anticipating Student</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rationale Guidance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiences</td>
<td>Questions</td>
</tr>
<tr>
<td>Act. Sequences</td>
<td>Reasoning &amp; Proof</td>
</tr>
<tr>
<td>Representations</td>
<td>Math Terminology</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Features</td>
</tr>
<tr>
<td></td>
<td>Storyline</td>
</tr>
<tr>
<td></td>
<td>Goals</td>
</tr>
<tr>
<td></td>
<td>Philosophy</td>
</tr>
</tbody>
</table>

Distribution of “-you”-forms

Imperatives = “you”+modal verb

You might suggest that they imagine a point leaving a trail (CMP, KHM, p. 53)

You should emphasize that the value could be found by solving an equation (UCSMP, Some Imp Geom Ideas, p. 397)

Types of Guidance

<table>
<thead>
<tr>
<th>Variable Transformations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enactment</td>
</tr>
<tr>
<td>CMP</td>
</tr>
<tr>
<td>Glencoe</td>
</tr>
<tr>
<td>MiC</td>
</tr>
<tr>
<td>UCSMP</td>
</tr>
</tbody>
</table>

Expression

Personal Pronouns

Value could be found by solving an equation (UCSMP, Some Imp Geom Ideas, p. 397)

You should emphasize that the value could be found by solving an equation (UCSMP, Some Imp Geom Ideas, p. 397)