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Developing the Horizon Content Knowledge of Teachers through a Math Teachers’ Circle

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Developing the Horizon Content Knowledge of Teachers through a Math Teachers’ Circle

Abstract
Although much of the training pre-service mathematics teachers receive is either in mathematical content or educational theory and pedagogy, research indicates that mathematical knowledge for teaching (MKT), which lies in a sense at the intersection of the two, is a factor in teacher quality. Unfortunately, none of the recent improvements in teacher preparation necessarily affect in-service mathematics teachers. One successful program affecting in-service teachers nationwide is the Math Teachers’ Circle Network. One strand of MKT that I believe math teachers’ circles are in a position to affect is Horizon Content Knowledge (HCK). Although taking advanced mathematics courses may improve HCK, often those courses are not taught in light of school mathematics, so it is left for the students to make the connections for themselves. In this talk I will discuss my work in starting a math teachers’ circle in NW Iowa with a goal of developing horizon content knowledge in teachers. I will share some of the materials I have used which make connections between school and advanced mathematics in a genuine way as well as its effect on the HCK of the participants.

Keywords
in-service teachers, Math Teachers’ Circle Network, Horizon Content Knowledge, HCK

Disciplines
Education | Mathematics

Comments
Presented as part of the American Mathematical Society Special Session on Creating Coherence in K--12 Mathematics at the Joint Mathematics Meetings of the American Mathematical Society and the Mathematical Association of America, held in San Antonio, Texas, January 10-13, 2015.
Developing the Horizon Content Knowledge of Teachers through a Math Teachers’ Circle
Creating Coherence in K–12 Mathematics, II

Thomas Clark
Dordt College

January 12, 2015
A few leading questions:

- What is Horizon Content Knowledge?
- Why is it important?
- Can teachers develop theirs through participating in a math teachers’ circle?
Some Background

- Shulman - Pedagogical Content Knowledge.
- Ball, Hill and colleagues - Math Knowledge for Teaching.
- Can it be measured? Does it affect student outcomes? Which parts are most important?
Horizon Content Knowledge

From Ball, Thames, Phelps (2008):

*Horizon knowledge is an awareness of how mathematical topics are related over the span of mathematics included in the curriculum.*

This is refined by Ball and Bass (2009).

*We define horizon knowledge as an awareness - more as an experienced and appreciative tourist than as a tour guide - of the large mathematical landscape in which the present experience and instruction is situated. It engages those aspects of the mathematics that, while perhaps not contained in the curriculum, are nonetheless useful to pupils’ present learning, that illuminate and confer a comprehensible sense of the larger significance of what may be only partially revealed in the mathematics of the moment.*
Is Math Teachers’ Circle an Avenue to Develop HCK?

Thomas Clark (Dordt College)

JMM - Developing HCK through MTCs

January 12, 2015
Some Loose Data

I sampled via a questionnaire the 11 teachers at my MTC.

*My teaching improves when I learn new pedagogical techniques.*

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*The mathematics I learned in college connects to the mathematics I now teach.*

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

*Good teaching is informed by a deep understanding of mathematics.*

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Data Continued

I teach mathematics because I enjoy doing mathematics.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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</thead>
<tbody>
<tr>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

I have an answer when students ask “when will I ever use this?”

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
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</tbody>
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Example 1: Algebra

Question

What horizon knowledge should teachers have in order to teach the quadratic formula well?
Example 1: Algebra

Question

What horizon knowledge should teachers have in order to teach the quadratic formula well?

- (Its derivation via completing the square.)
- Applications of finding roots.
- Some history of solving algebraic equations e.g., Cardano’s formula.
- Fundamental Theorem of Algebra.
- Abel-Ruffini Theorem
Example 1: Algebra

Question

What horizon knowledge should teachers have in order to teach the quadratic formula well?

- (Its derivation via completing the square.)
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- Fundamental Theorem of Algebra.
- Abel-Ruffini Theorem

This is an example of starting with the content of school mathematics and looking ahead to its applications, consequences, and theoretical underpinnings.
Example 2: Function Composition

Question

Take a strip of paper, make a mark in it and then alternatively fold the left and right edges to the most recent fold. What happens if you continue this process?
Example 2: Function Composition

Question

Take a strip of paper, make a mark in it and then alternatively fold the left and right edges to the most recent fold. What happens if you continue this process?

- Modeling with mathematics.
- Thinking about limiting processes.
- Dynamical systems.
- Contraction mapping principle.
Example 2: Function Composition

**Question**

*Take a strip of paper, make a mark in it and then alternatively fold the left and right edges to the most recent fold. What happens if you continue this process?*

- Modeling with mathematics.
- Thinking about limiting processes.
- Dynamical systems.
- Contraction mapping principle.

This is an example of starting with straightforward question and looking ahead to its applications, consequences, and theoretical underpinnings.
Example 3: Decimals

**Question**

What horizon knowledge should teachers have to teach decimal numbers? (Why is $0.9 = 1$?)
Example 3: Decimals

Question

What horizon knowledge should teachers have to teach decimal numbers? (Why is $0.\bar{9} = 1$?)

- Place value.
- Infinite series.
- Natural Numbers $\rightarrow$ Integers $\rightarrow$ Rationals $\rightarrow$ Reals $\rightarrow$ Complex Numbers.
Concluding Thoughts

- Is this a good way to develop HCK?
- Can it be measured? Does that matter?
- MTCs should be beneficial to teachers regardless of the choice of content, but one can organize a circle around this concept and perhaps over a period of time give teachers opportunities to grow in their knowledge of the mathematical horizon and see more coherence in the curriculum.
Thanks for your time.


Any Questions?