Balancing Self-Directed Learning with Expert Mentoring: The Science Writing Heuristic Approach

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Science Writing Heuristic Learning Approach

• Embeds science argument within typical inquiry lessons
• Promotes critical thinking and reasoning and uses language as a mediating tool for negotiating the understanding of science
• Students are required to
  • pose questions
  • generate claims and evidence
  • compare their answers to others
  • reflect on changes in their understanding
Goal:

- Examine the impact of implementation of the SWH approach on critical thinking
  - Critical thinking was assessed using the Cornell Critical Thinking Test
  - Decompose impact of implementation into individual factors that can be addressed in PD sessions.
  - Teachers were evaluated using the Reformed Observation for Teaching Protocol (RTOP) instrument
Setting and Intervention

**Location of 24 Control Schools**

- Count
  - 0.0
  - 0.5
  - 1.0
  - 1.5
  - 2.0
  - 2.5
  - 3.0

**Location of 24 SWH Schools**

- Count
  - 0.0
  - 0.5
  - 1.0
  - 1.5
  - 2.0
  - 2.5
  - 3.0
Data Collection

- The CCT test was administered in a Fall 2010 pretest and a Spring 2011 posttest
- Demographic information about individual students was obtained from Iowa Assessments
- Teachers submitted a video of them teaching one entire lesson
- Videos were rated by researchers at the University of Iowa using a modified version of the RTOP instrument
Data Summary

- Multiple Imputation was used to impute missing data values
- 2012/2450 students were administered the Cornell Critical Thinking Tests twice, pre and post school year
- 38/85 Teachers submitted a video to be evaluated
- 1202/2405 complete cases
Critical Thinking Score Improvement

Using student level data and ignoring multilevel structure

Year 1 (fall10 and spring11):
SWH mean: 4.775
Control mean: 3.698
Cohen's d: 0.155
P-Value: 0.0005

Year 2 (fall11 and spring12):
SWH mean: 4.634
Control mean: 2.528
Cohen's d: 0.242
P-Value: <0.0001
Modified RTOP Instrument

- 14 Questions selected from original 25
- Targeting Four Dimensions
  - Lesson Design and Implementation
  - Procedural Knowledge
  - Communicative Interactions
  - Student/Teacher Relationships
Average Modified RTOP Ratings

2010-2011 Academic Year
SWH Mean: 1.797
Control Mean: 1.273

2011-2012 Academic Year
SWH Mean: 2.062
Control Mean: 1.324
Rater [In]Consistency

2010-2011 Academic Year

Rater Bias

2011-2012 Academic Year

Rater Bias

Instrument
RTOP

Iowa State University
<table>
<thead>
<tr>
<th>Q1</th>
<th>Factor1</th>
<th>Factor2</th>
<th>Factor3</th>
<th>Factor4</th>
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Multilevel Model

- Student Level Response: Change in Score on Cornell Critical Thinking Test from Pretest to Posttest
- Teacher Level Response: Average RTOP Score, RTOP Dimension Factor Scores
- Covariates: Demographic indicators, Socioeconomic indicators, and learning indicators
Multilevel Model

- Linear Random Effects model with Teacher and School treated as random terms
- Improvement ~ Pre-score + Learning Process + Average RTOP Score + RTOP Dimension Factor Scores + White Student + Black Student + Hispanic Student + Asian Student + IEP Student + Free and Reduced Lunch Status + Gifted and Talented Student + (1| Teacher) + (1|School)
## Multilevel Model for 2010-2011 Academic Year

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Full Model</th>
<th>Reduced Model</th>
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<tbody>
<tr>
<td></td>
<td>Effect</td>
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# Multilevel Model for 2011-2012 Academic Year

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Teacher Effect by County

2010-2011 Academic Year  2011-2012 Academic Year

Average Teacher Random Effect by County

Average Teacher Random Effect by County
School Effect by County

2010-2011 Academic Year  2011-2012 Academic Year

Average School Random Effect by County

IOWA STATE UNIVERSITY
Science Writing Heuristic
Conclusions

• The Science Writing Heuristic learning approach is having a significant increase in critical thinking scores.
• The SWH learning approach decreases the learning gap by bringing the bottom up.
• The effect of Teacher level predictors are not, currently, statistically significant.
• Teacher RTOP ratings are unreliable and add substantial variability to the model.