

IOWA STATE UNIVERSITY

Science Writing Heuristic

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

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Science Writing Heuristic Learning Approach

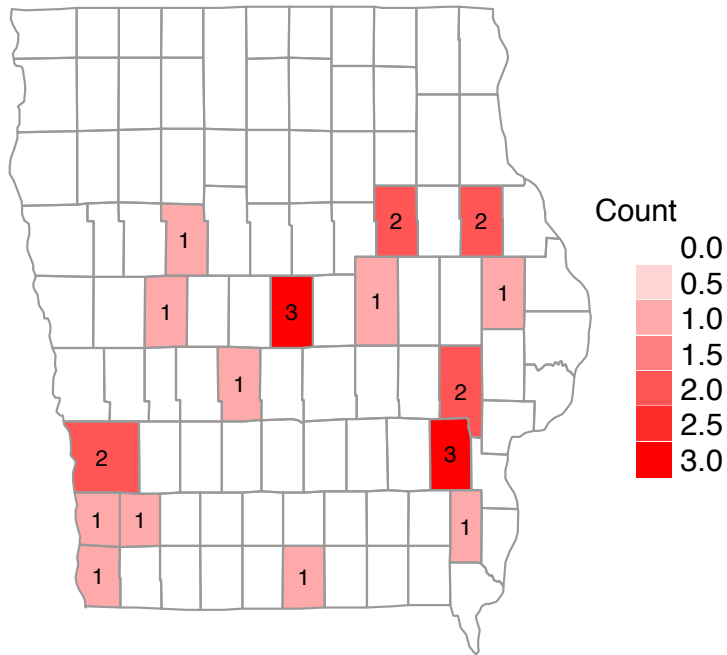
- Embeds science argument within typical inquiry lessons
- Promotes critical thinking and reasoning and uses language as a mediating tool for negotiating the understanding of science
- Students are required to
 - pose questions
 - generate claims and evidence
 - compare their answers to others
 - reflect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

Goal:

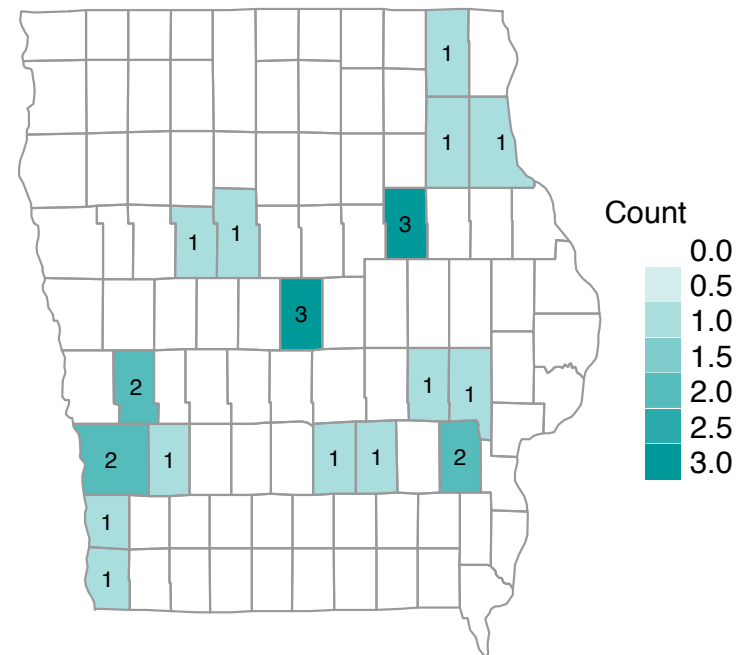
- Examine the impact of implementation of the SWH approach on critical thinking
 - Critical thinking was assessed using the Cornell Critical Thinking Test
- Decompose impact of implementation into individual factors that can be addressed in PD sessions.
 - Teachers were evaluated using the Reformed Observation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

Setting and Intervention

Location of 24 Control Schools



Location of 24 SWH Schools



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

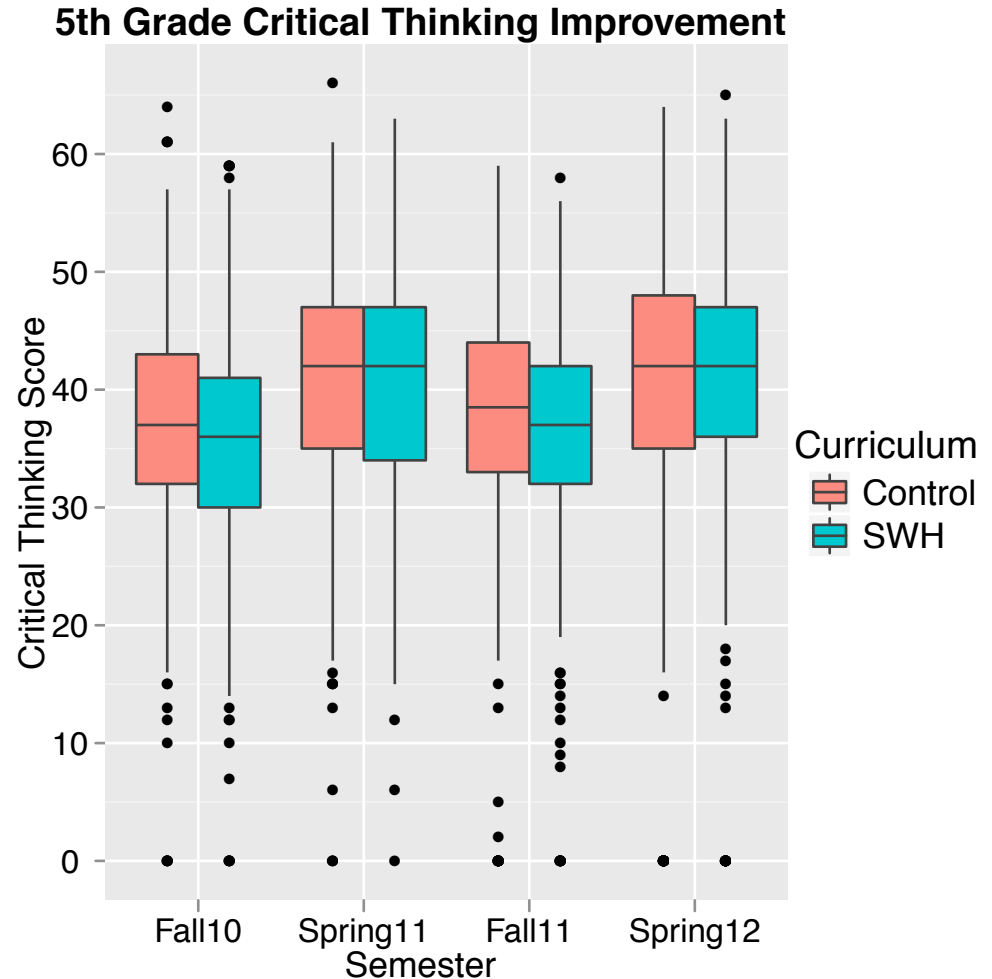
Year 2 (fall11 and spring12):

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

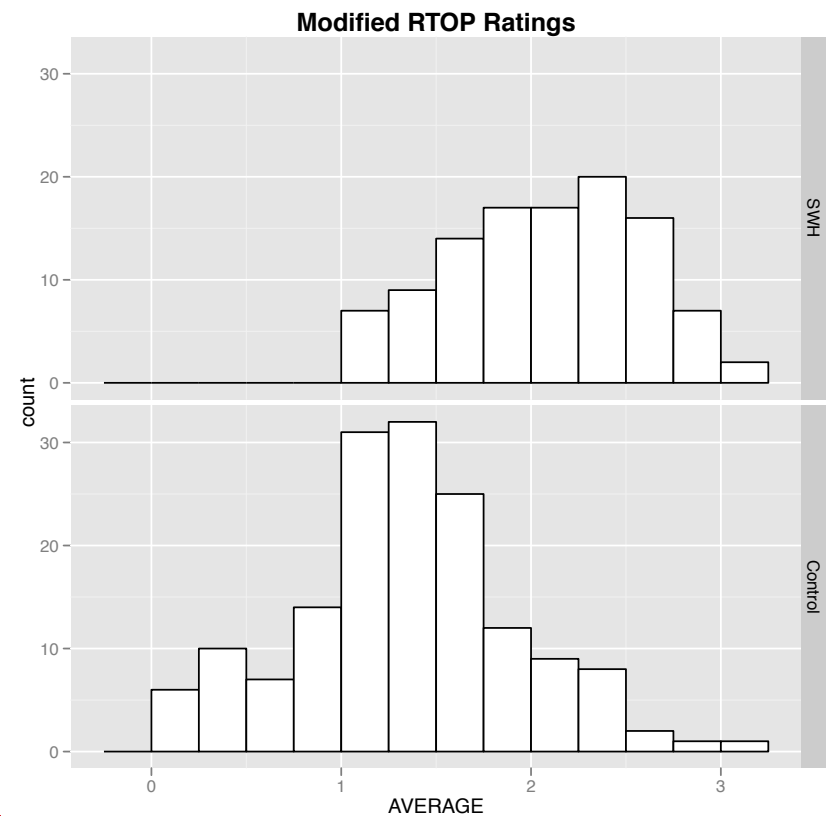
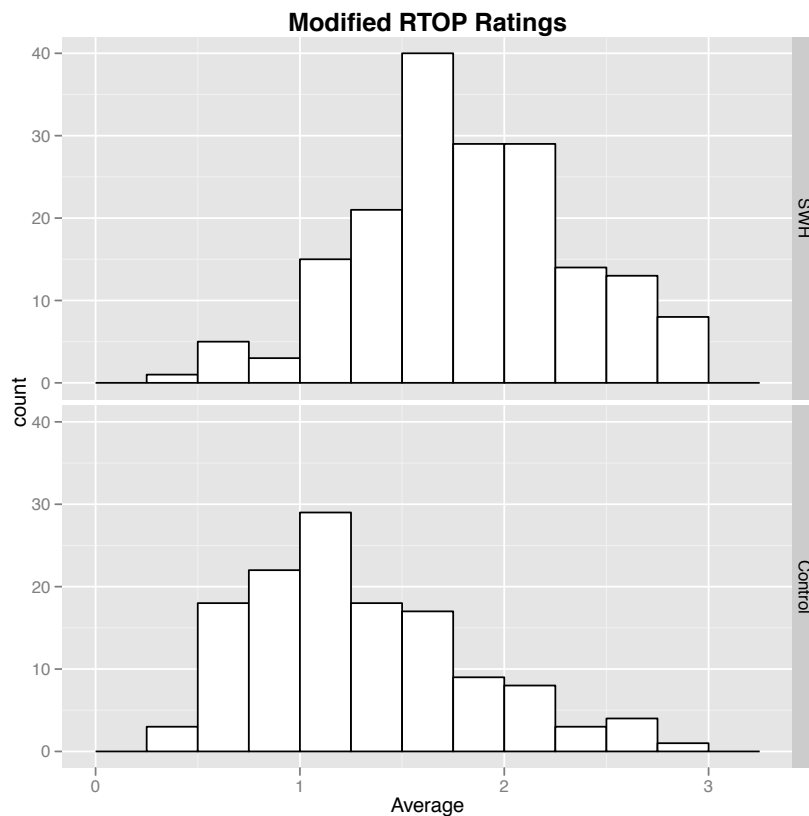
SWH Mean: 1.797

Control Mean: 1.273

2011-2012 Academic Year

SWH Mean: 2.062

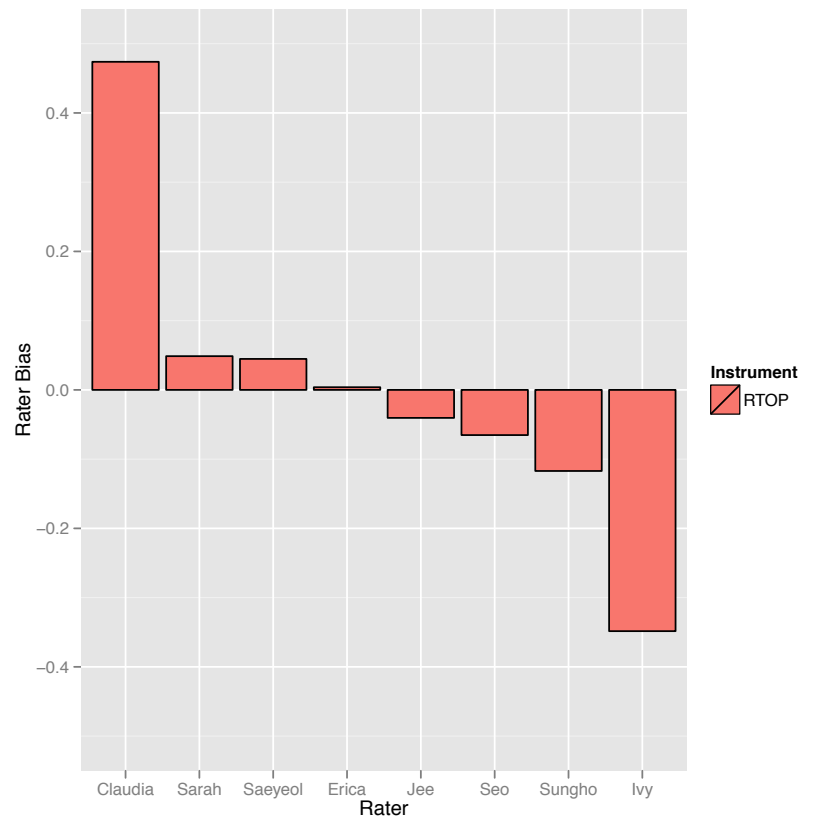
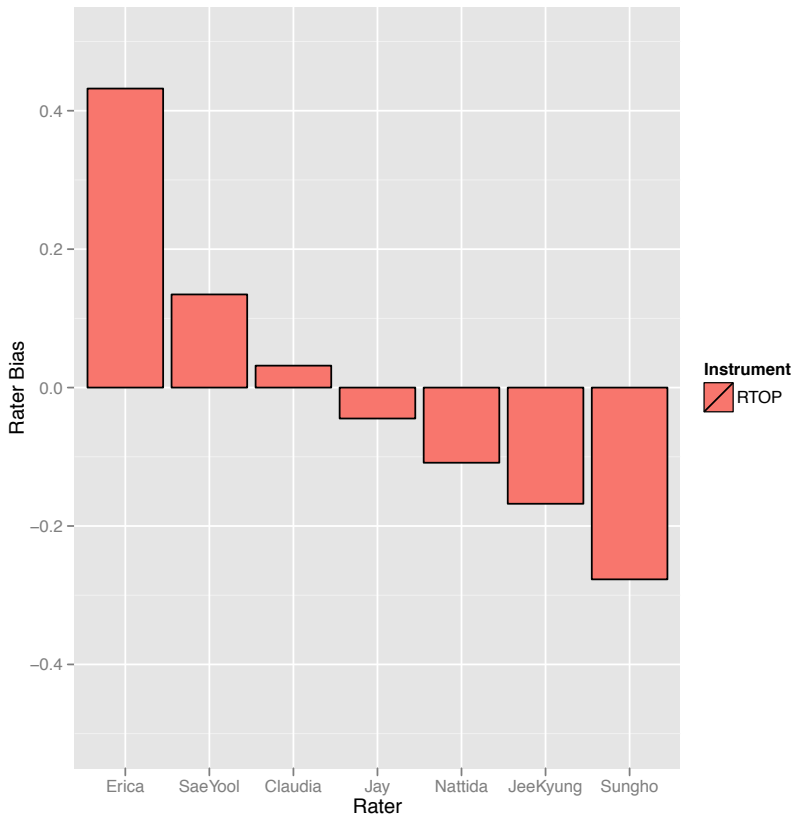
Control Mean: 1.324



Rater [In]Consistency

2010-2011 Academic Year

2011-2012 Academic Year



	Factor1	Factor2	Factor3	Factor4
Q1	0.514	-	-	-
Q2	0.600	0.547	-	0.531
Q3	-	0.582	0.479	-
Q4	-	0.881	-	-
Q5	0.306	0.776	-	-
Q6	-	-	0.629	-0.345
Q7	0.660	0.320	-	0.314
Q8	0.729	-	-	-
Q9	0.964	-	-	-
Q10	0.791	-	0.300	-
Q11	0.500	0.550	0.471	-
Q12	-	-	0.751	-
Q13	0.623	0.456	-	-
Q14	-	-	0.689	-

	Factor1	Factor2	Factor3	Factor4
Q1	0.609	-	-	-
Q2	0.677	0.335	-	0.331
Q3	0.342	0.375	-	0.731
Q4	0.595	-	-	-
Q5	0.765	-	-	-
Q6	-	-	0.536	-
Q7	0.621	-	-	0.486
Q8	0.651	0.555	-	-
Q9	-	0.907	-	-
Q10	0.345	0.702	-	-
Q11	0.779	0.432	0.337	-
Q12	0.300	-	0.462	-
Q13	0.503	0.398	0.426	-
Q14	-	-	0.883	-

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 \sim 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

Parameter	Full Model		Reduced Model	
	Effect	P-value	Effect	P-value
Pre-Score	-0.424	0.000	-0.423	0.000
TRTSWH	1.749	0.152	1.598	0.157
WHT	2.197	0.041	2.194	0.040
IEP	-4.221	0.000	-4.229	0.000
ASN	2.230	0.105	2.267	0.100
HSP	-0.494	0.599	-0.471	0.617
BLK	0.021	0.983	0.018	0.985
GAT	3.511	0.000	3.510	0.000
FRL	-1.079	0.010	-1.078	0.009
Factor1	-0.167	0.800	-	-
Factor2	-0.655	0.328	-	-
Factor3	0.057	0.917	-	-
Factor4	0.264	0.617	-	-
RTOP Average	0.572	0.677	-	-

Multilevel Model for 2011-2012 Academic Year

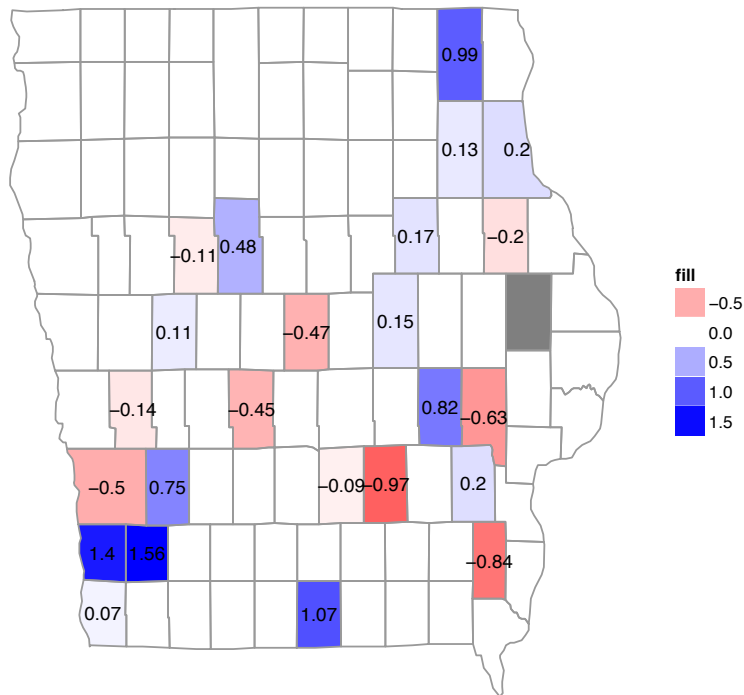
Parameter	Full Model		Reduced Model	
	Effect	P-value	Effect	P-value
Pre-Score	-0.434	0.000	-0.432	0.000
TRTSWH	1.030	0.162	1.315	0.047
WHT	0.606	0.586	0.611	0.582
IEP	-4.326	0.000	-4.321	0.000
ASN	0.476	0.728	0.549	0.687
HSP	-1.554	0.078	-1.526	0.082
BLK	-0.617	0.580	-0.604	0.587
GAT	2.690	0.000	2.676	0.000
FRL	-0.753	0.042	-0.738	0.042
RTOP Average	-1.292	0.735	-	-
Factor1	0.866	0.580	-	-
Factor2	0.081	0.945	-	-
Factor3	0.531	0.503	-	-
Factor4	0.366	0.537	-	-

Teacher Effect by County

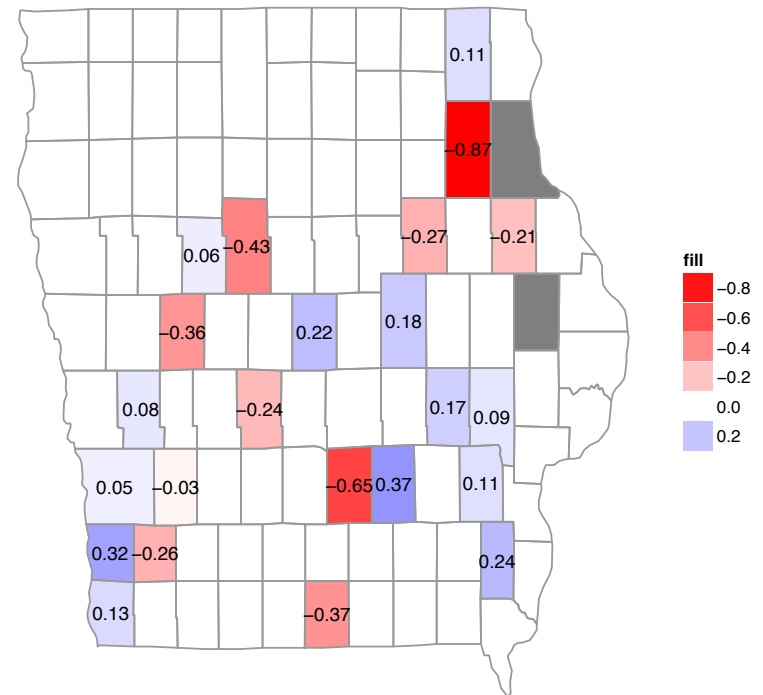
2010-2011 Academic Year

2011-2012 Academic Year

Average Teacher Random Effect by County



Average Teacher Random Effect by County

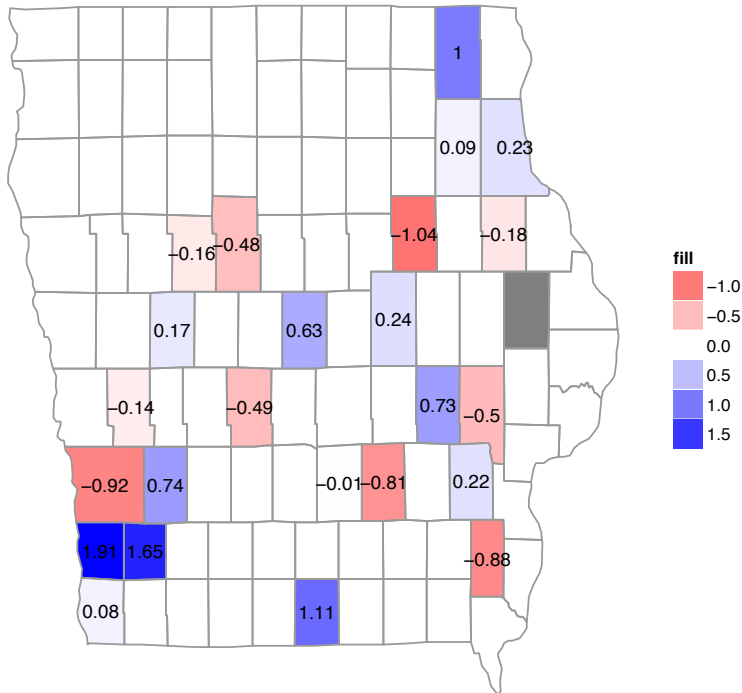


School Effect by County

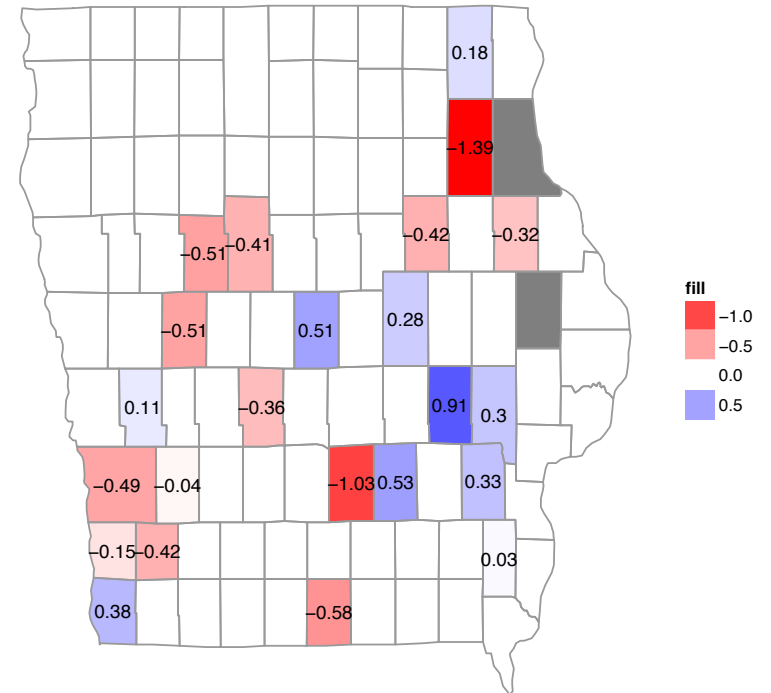
2010-2011 Academic Year

2011-2012 Academic Year

Average School Random Effect by County



Average School Random Effect by County



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.