Investigation of Cornell Critical Thinking Results as Affected by Science Writing Heuristic

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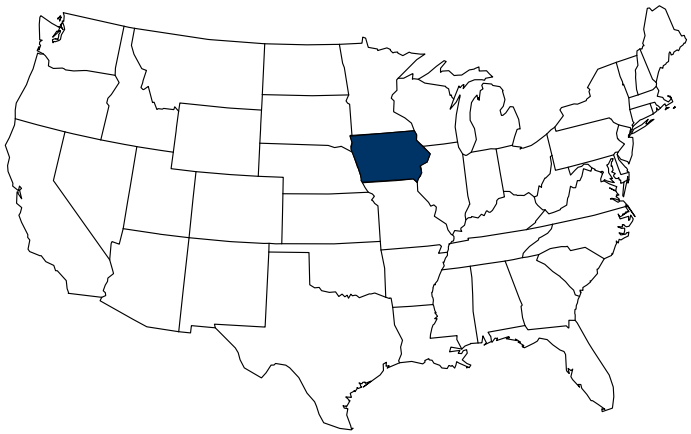
August 31, 2012

Outline

1. Science Writing Heuristic
2. Cornell Critical Thinking Test (CCT)
3. IRT analysis of year 1 CCT scores
4. Results from the new year 2 data



Science Writing Heuristic

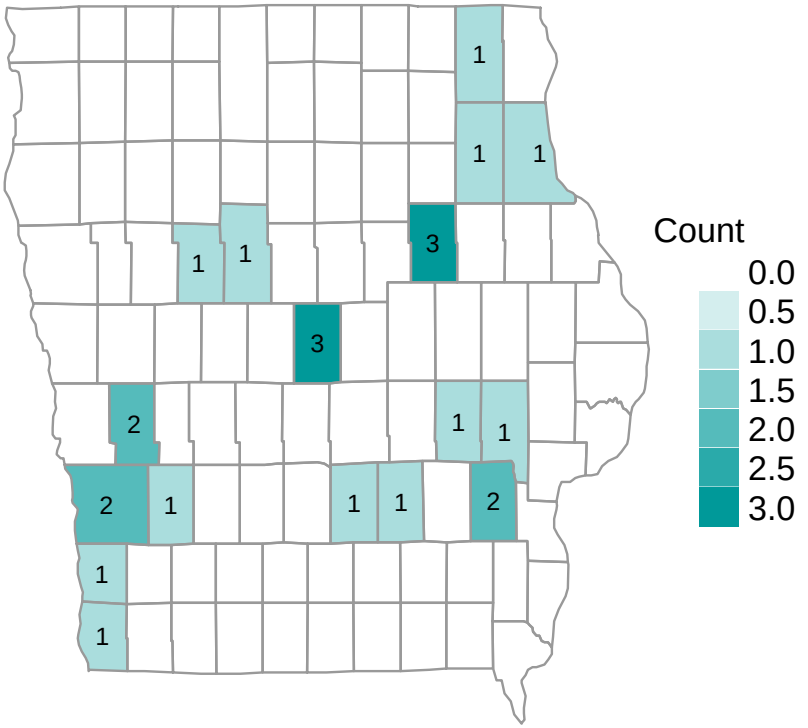
- Embeds science argument within typical inquiry lessons
- Promotes critical thinking and reasoning
- Uses language as a mediating tool for negotiating the understanding of science
- Students are required to
  - pose questions
  - generate claims and evidence
  - compare their answers to others
  - reflect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

Framework

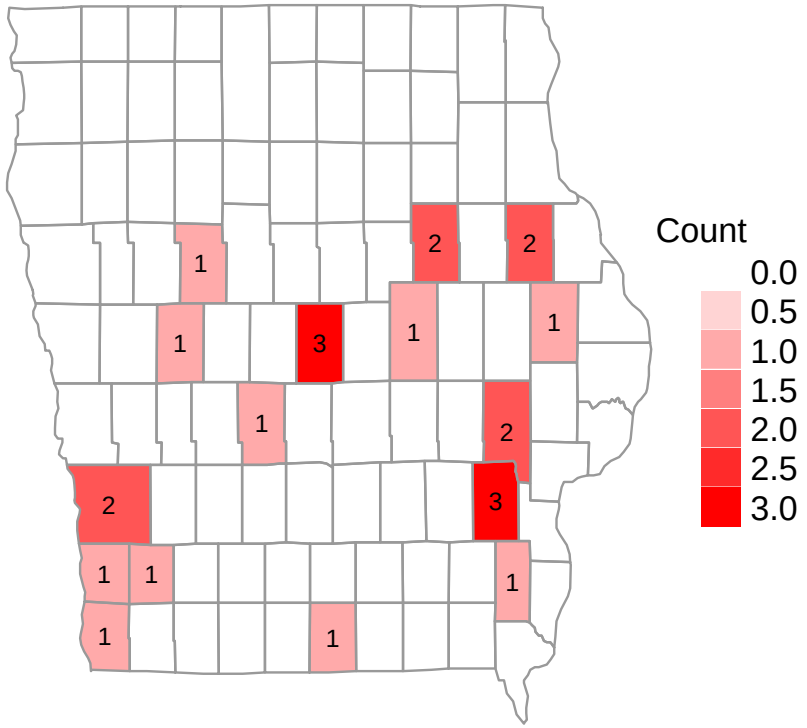
- To date there has been little to no research investigating the increase in critical thinking as a result of a different style of learning presented in Science class.
- This new method of teaching of Science was implemented through the Science Writing Heuristic grant program within a Midwestern state consisting of 48 schools; here the students were all in the 5th grade at their institution.

Cluster Randomized Design

Location of 24 SWH Schools



Location of 24 Control Schools



Sample

- Within these 48 schools which were randomly assigned to be in the treatment or control groups there was a total of 2303 students.
- Of this total number students who were labeled as Special Education or being in Gifted and Talented were removed.
- This was needed to investigate the possible effects on what is considered the typical student. Leaving a sample size of 1543 5th grade students.

Sample

	Female	Male	Total
Control	335	341	676
SWH	438	429	867
Total	773	770	1543

Cornell Critical Thinking Test

- The standard for critical thinking tests as well as being the most widely recognized.
- 50 minutes to answer 71 Questions.
- Comprised of four components:
  - Induction
  - Deduction
  - Observation / Credibility
  - Assumption

Cornell Critical Thinking Test

- The test was split into its four components with their relative questions.
- Each question only has one correct answer which is labeled as 1 and 0 for an incorrect answer (i.e. dichotomous).
- The combination of students and component questions is the inputted into the Winsteps (Linacre 2007) program in order to derive the person ability and item difficulty scores as scaled by the Rasch Model.

Results: All Students

Component	Treatment	n	Mean	SD	Hedges G
Induction	Control	685	0.28614	0.84475	0.166
	SWH	886	0.42586	0.83999	
Deduction	Control	685	0.32432	0.87578	0.094
	SWH	886	0.40425	0.83025	
Observation	Control	685	0.12965	0.81945	0.049
	SWH	886	0.16998	0.81343	
Assumption	Control	685	0.18483	1.28210	-0.019
	SWH	886	0.16059	1.29992	

Results: Female Students

Component	Treatment	n	Mean	SD	Hedge's G
Induction	Control	335	0.29426	0.84603	0.137
	SWH	438	0.40271	0.74942	
Deduction	Control	335	0.38403	0.90438	0.062
	SWH	438	0.43933	0.87226	
Observation	Control	335	0.12489	0.81699	0.017
	SWH	438	0.13856	0.82012	
Assumption	Control	335	0.22319	1.32168	0.040
	SWH	438	0.27803	1.38335	

Results: Male Students

Component	Treatment	n	Mean	SD	Hedge's G
Induction	Control	341	0.28282	0.84625	0.184
	SWH	429	0.44513	0.91076	
Deduction	Control	341	0.25205	0.84191	0.154
	SWH	429	0.37767	0.79365	
Observation	Control	341	0.14642	0.82174	0.079
	SWH	429	0.21089	0.81181	
Assumption	Control	341	0.10372	1.21709	-0.045
	SWH	429	0.04879	1.21592	

Results

- All components except 'Assumption' had small positive effects in favor of SWH.
- The Induction and Deduction abilities indicated a small effect for males in the SWH group.
- Hedges G noted small effects for the Induction with respect to the SWH treatment

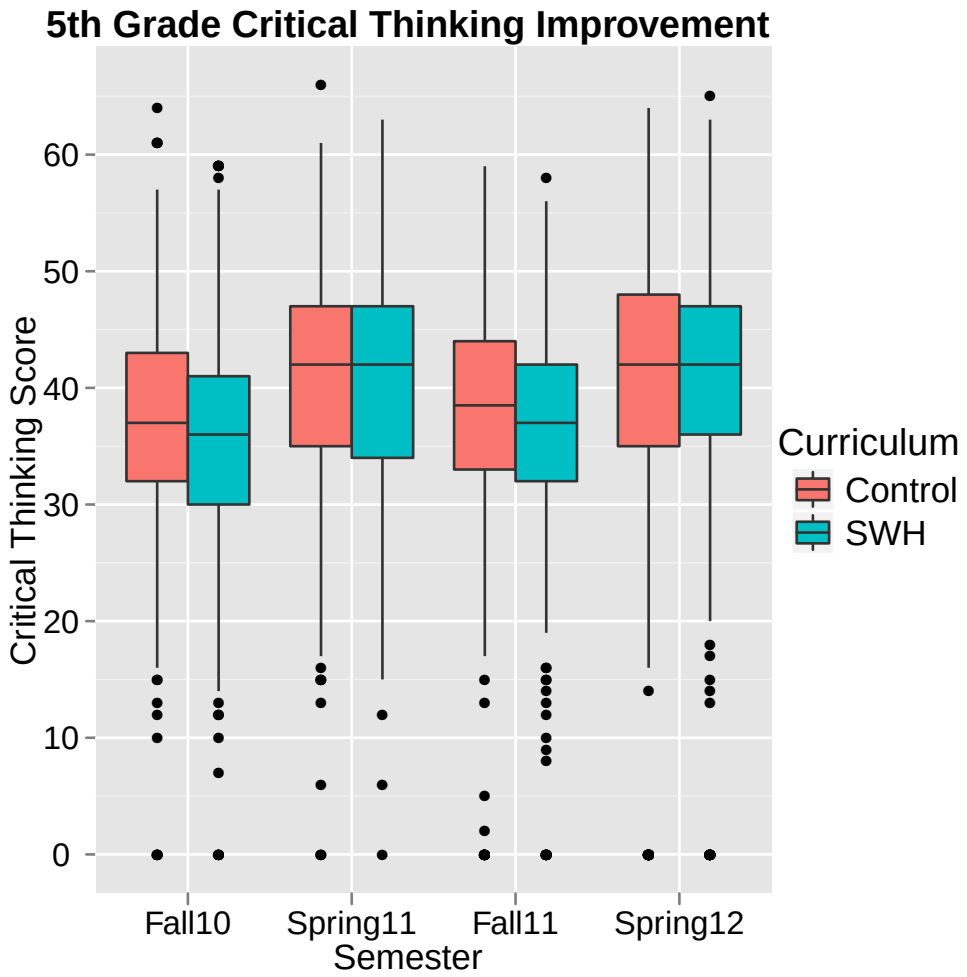
Total CCT Improvement

Year 1 (Fall 10 and Spring 11):

SWH mean	4.775
Control mean	3.698
Cohen's d	0.155
P-Value	<0.001

Year 2 (Fall 11 and Spring 12):

SWH mean	4.634
Control mean	2.528
Cohen's d	0.242
P-Value	<0.001



Conclusions

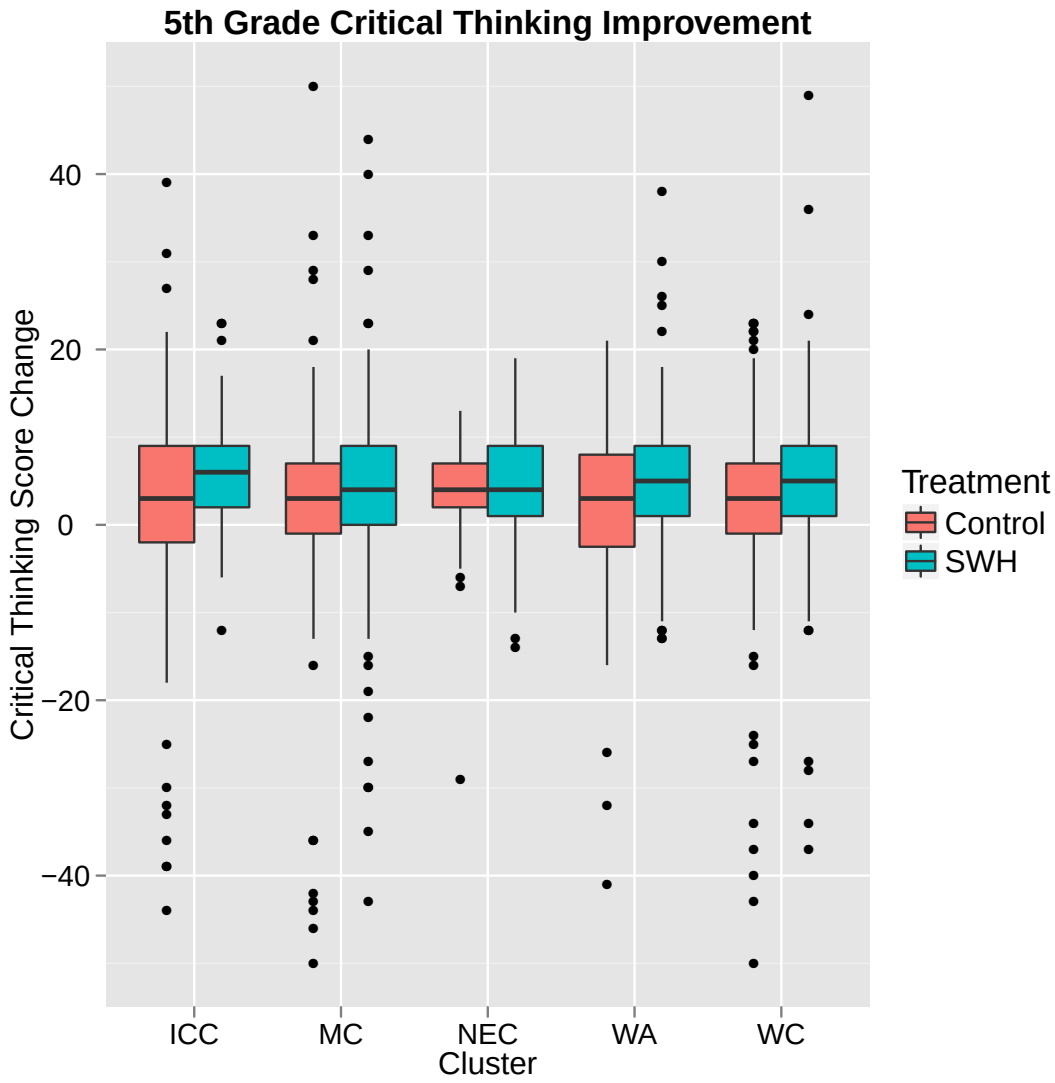
Cluster	SWH Mean	Control Mean	Difference	Cohen's d	P-value
ICC	5.783	2.459	3.324	0.348	$<$0.001
MC	3.934	2.637	1.297	0.133	0.113
NEC	4.527	3.692	0.835	0.133	0.340
WA	5.255	1.639	3.617	0.441	$<$0.001
WC	4.542	2.469	2.073	0.254	0.001
Overall	4.635	2.528	2.107	0.243	$<$0.001

Table : Summary statistics for the Cornell Critical Thinking Test from the 2011-2012 school year. Results are presented for each cluster along with the overall result.

Cluster Impact

2011-2012 Results

Cluster	Effect Size
ICC	0.348
MC	0.133
NEC	0.133
WA	0.441
WC	0.254
Overall	0.243



Conclusions

- In almost all cases the SWH treatment showed an improvement in critical thinking ability, but effects were small.
- Effect sizes were consistent for Induction across gender lines.
- When evaluating the total score, students in schools with the greatest diversity showed the largest gains.

Acknowledgements and SWH References

- Research funded by a grant from the US Department of Education through the Institute of Education Sciences, award number R305A090094-10.

- Brian Hand Ph.D.

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- Hand, B. Ed., Science Inquiry, Argument and Language: A Case for the Science Writing Heuristic (Sense Publishers, Rotterdam, Netherlands, 2007).