

Multiple-Text Processing in Text-Based Scientific Inquiry

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Abstract: This study examined multiple-text processing in the context of text-based scientific inquiry for purposes of generating causal models. We used a series of rubrics to examine students' use of the texts, the quality of the causal models they created, and the impact of text use on model quality. Results indicate that multiple text users engaged with the texts in qualitatively different ways and created significantly higher quality models than single text users.

Objectives

This study examined how students used an intentionally designed text set to generate causal models of the carbon cycle prior to and following an instructional intervention. Using a series of rubrics, we analyzed the pre/post models to determine the extent to which students made use of the texts and the quality of the models that they created. We then examined the relationship between text use and model quality, focusing on the role of multiple-text processes.

Theoretical Framework

Consistent with authentic practices of the discipline, scientific literacy involves working with multiple sources to acquire information (Chinn & Malhotra, 2002). When scientists read articles to advance their understanding of a phenomenon, they engage in multiple-text processing to evaluate, corroborate, and synthesize sources of evidence for particular models and theories (Bazerman, 1985). However, novices tend to approach sources separately and uncritically, failing to notice connections among them (Wolfe & Goldman, 2005). Text processing research provides insights into the challenges associated with multiple-text processing and the role of this practice in scientific understanding. Initial research indicates that deep engagement in text processing plays a role in understanding, but additional work is needed to examine this relationship. The current study endeavors to build on this body of work by examining the ways that students make use of multiple texts in a text-based inquiry context and the impact of text use on scientific understanding as represented by model quality.

Methods and Data Sources

This study occurred in the context of an ongoing design-based research project investigating evidence-based argumentation and multiple text use in middle and high school history, science, and literature classrooms (Goldman et al., 2009; Greenleaf et al., 2013). The specific focus of this study is a three-week implementation of a text-based inquiry module on the water cycle conducted in a 6th grade science classroom located in an urban, Midwest public school. Pre and post module, students completed an assessment that engaged them in the same reading and inquiry practices taught during the module but for a different topic. The pre/post text set was designed to facilitate an investigation of students' text use and multiple-text processing in that it required the selective use of information from multiple texts and cross-text synthesis to produce a complete causal model. The four texts included several different types of information, including running text and illustrations. During the pre/post assessment, students were asked to read and annotate the texts. They were then asked to use information from the texts to create a model that explained how and why the scientific phenomenon occurred. The pre/post assessment was administered individually to each student in the class one day prior to and two days following the instructional module. Pre- and post-test data were available for 22 consented students.

The analytic approach was designed to capture the range of performances on the pre/post modeling task across students and changes in performance from pre to post instructional intervention. The performances of interest were students' use of the texts and the causal models that they constructed. The pre/post assessment was administered individually to each student in the class one day prior to and two days following the conclusion of the instructional module. Pre/post test data was available for 22 consented students.

The models constructed during the pre and post assessment constitute the data source for this poster. These models were coded for text use and model quality using two rubrics that were developed through an iterative refinement process of generating criteria, applying them to student work, and revising the criteria to effectively capture variation.

Rubric for text use. This rubric allowed us to trace the information in each model to the texts that each student used to create their model. We identified the type of information that was used including 1) running text, 2) illustration. Overall text use was evaluated based on the number of texts used (1) none, 2) single, 3) multiple).

Rubric for model quality. Model quality was scored against an “expert” model of the elements and causal links in the model, as reflected across the text set. Models were scored for how many of the elements (max = 3) and links (max = 2) in the expert model that were reflected in the student’s model.

Results

Our findings indicate that students varied in the extent to which they made use of the texts that were provided during this task. We also found a small pre/post shift from single to multiple text use for those students who made use of the texts. At pre, 59% of students used a single text, 36% used multiple (two or more) texts, and only 5% failed to use any texts. At post, 41% of students used a single text, 50% used multiple texts, and 9% failed to use any texts. This indicates that some students were more aware of the need to examine and use multiple texts than others.

Our findings suggest that students in these groups engaged with the texts in qualitatively different ways. We found that 62% of single text users at pre and 67% at post only made use of one of the two illustrations in the text set. In contrast, 62% of multiple text users at pre and 64% at post used illustrations in addition to running text, while other multiple text users (38% at pre, 36% at post) only used running text. This suggests that single text users largely relied on illustrations to create their models whereas multiple text users engaged with all aspects of the texts. We also found that only multiple text users included causal links in their models. In fact, 63% of multiple text users at pre and 73% at post included one or more causal links. In contrast, no single text users included causal links at either time point. This indicates that only multiple text users were making connections within and across texts.

We found that these variations in text use led to important differences in model quality. A one-way, between subjects analysis of variance was conducted on post-test data comparing the effect of text use on (1) number of elements (2) number of causal links for no text, single text, and multiple text groups. These analyses revealed a significant effect of text use on model quality with respect to the number of elements, $F(2,19)=45.017$, $p<.001$, and the number of links, $F(2,19)=9.00$, $p=.002$, that students included in their models. Planned comparisons revealed that students who used multiple texts included significantly more elements than students who used a single text, $t(19)= 8.14$, $p<.001$, and students who used no texts, $t(19)=6.85$, $p<.001$. Multiple text users also included significantly more causal links than students who used single texts, $t(19)=4.03$, $p=.001$, and students who used no texts, $t(19)=2.35$, $p=.03$. Thus, our findings suggest that the unique ways that multiple text users engaged with the texts, particularly their engagement with all aspects of the texts and synthesis within and across texts, led to the creation of high quality models that reflect a complete, integrated understanding of the phenomenon.

Implications

This work provides insight into the challenges associated with multiple-text processing and highlights the impact of this practice on scientific understanding. The findings from this work will be used to inform the development of curricular materials to support these critical scientific literacy practices.

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