EasyChair Preprint

№ 3846

Benefits from Sketching When Learning From Geoscience Texts

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July 12, 2020

Benefits from Sketching when Learning from Geoscience Texts

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This research was supported by a grant from the National Science Foundation (DUE 1535299). Tim George is now at Union College.

This preprint is based on a conference submission to the 2020 Society for Text & Discourse archived on Easychair. This document should be cited as:

Wiley, J., Griffin, T. D., & George, T. (2020). *Benefits from sketching when learning from geoscience texts* (No. ZZZZ). EasyChair. https://easychair.org/publications/preprint/YYYY

Abstract

Although frequently used with expository texts, illustrations can lead to illusions of understanding. When students studied geoscience texts without sketching, both comprehension and monitoring were poor if only some topics in a set were illustrated. However, when students were prompted to generate a sketch while reading, both comprehension and monitoring were improved by sketching.

Keywords: expository text, learning from text, multimedia, comprehension, metacomprehension

Benefits from Sketching when Learning from Geoscience Texts

Science textbooks often include images, consistent with assumptions that visualizations can be supportive of better understanding in science (Mayer, 1989). Yet, sometimes images can cause seduction effects that undermine learning (Harp & Mayer, 1998; Sanchez & Wiley, 2006). Recent work on illusions of understanding suggests that the presence of images can also impact beliefs about learning, and readers' ability to monitor their own learning (Cardwell et al., 2017; Jaeger & Wiley, 2014; Serra & Dunlosky, 2010; Wiley et al., 2017). If students are deceived about their own level of understanding by the presence of images, then poor learning can result from spending too little time or effort attempting to construct mental models from text.

An alternative to presenting images is to prompt students to draw sketches as they read (Gobert & Clement, 1999; Van Meter & Garner, 2005). A general advantage of sketching is that it prompts constructive processing and active integration of information by readers (Hall, Bailey, & Tillman, 1997; Jaeger et al., 2018; Schwamborn et al., 2010). Activities that require generation have been shown to lead to more accurate metacomprehension (Griffin, Mielicki & Wiley, 2019; Griffin, Wiley, & Thiede, 2019). In contrast, simply presenting visualizations to readers may prompt passive information processing and a sense of fluency or ease (Wiley, 2019). Consistent with these arguments, Fukaya (2013) found that students who generated diagrams after reading texts (from Macaulay's "The Way Things Work") showed increased relative accuracy. Similarly, Schleinschok et al. (2017) found that students who engaged in drawing after reading were better able to monitor their understanding.

The main research questions tested in this study were whether the presence of images within a set of readings for a geoscience course would improve or undermine students' ability to monitor their comprehension, and whether engaging in sketching while reading would improve monitoring.

Method

Participants

Participants were 180 college students who had not yet taken an introductory course and had low prior knowledge of geology.

Materials

The materials were excerpts on 6 topics (Weathering, Mountains, Coal, Waves, Caves, and El Niño) taken from a college-level introductory geoscience textbook. The excerpts were written at the 11th grade level (Flesh-Kincaid) and ~950 words each. For each topic, the textbook illustration was a full-color, multi-paneled composite containing a mixture of photographic and other depictions of a causal process. Five multiple-choice questions were developed on each topic in collaboration with geoscience experts. The questions required the reader to make inferences and reason about the processes that were described, and did not rely simply on verbatim memory for the presented information.

Procedure

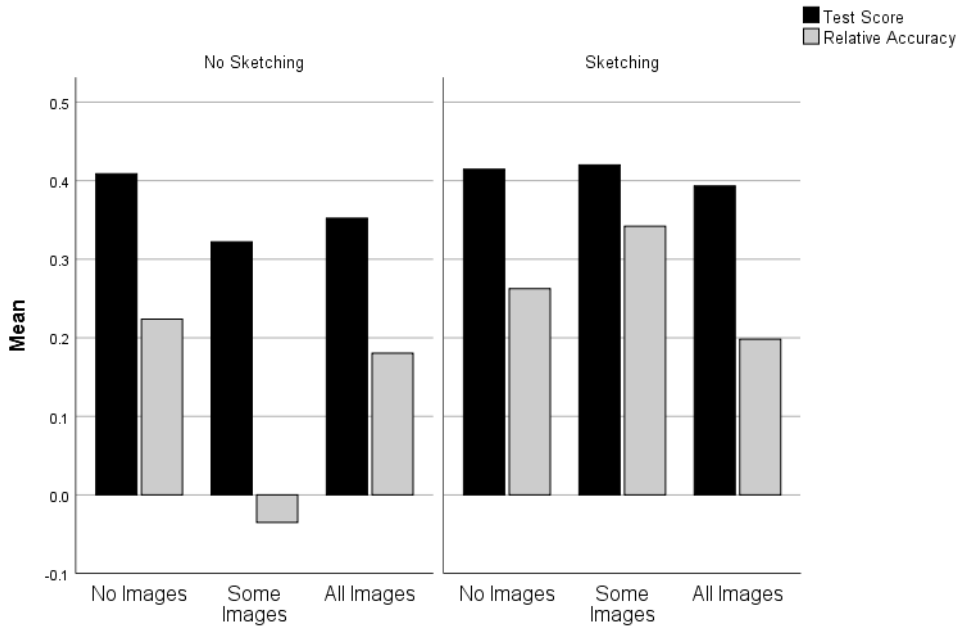
After reading each text, students provided judgments of understanding (JOUs) by predicting how many questions they would get correct on a quiz with 5 questions for each topic. Then, students completed the tests. All tasks were untimed. The presence of illustrations was manipulated so that all, none, or some (half, counterbalanced) of the excerpts had illustrations. Half of the students read without sketching. The other half were instructed that as they read they should draw a sketch that conveyed the important concepts about the process. They were told that the sketches did not need to be artistic or realistic, and could just be boxes and arrows. They were provided with paper booklets with separate blank pages to create their sketch for each excerpt.

Results

As shown in Figure 1, there was a significant effect of sketching on comprehension test scores. Scores in the no-sketching condition were lower, especially when only some topics were illustrated. However, the three illustration conditions performed similarly with sketching and sketching improved scores overall.

Figure 1

Effects of Sketching and Image Conditions on Test Score and Relative Accuracy



In addition, a measure of comprehension monitoring accuracy (relative accuracy) was computed as the intra-individual correlation between each student's predictive JOUs and their test scores across the set of topics. (Higher values reflect more accurate comprehension monitoring). This resulted in a significant benefit from sketching and a significant interaction. In the no-sketching condition, monitoring accuracy was especially poor when only some topics were illustrated. However, students experienced similar accuracy in three illustration conditions with sketching, and sketching improved comprehension monitoring accuracy overall.

Conclusions

It is common for geoscience textbooks to include illustrations for many topics, but at the same time, it is quite unlikely that every topic will be represented in an illustration. These results suggest that when only some content is presented with visualizations this can lead to both poorer comprehension monitoring and poorer comprehension outcomes. Since relative accuracy depends on making accurate judgments across a set of topics, it makes sense that variation in the presence of images across a set of

textbook excerpts would negatively impact relative accuracy. This result highlights an additional source of difficulty for engaging in accurate monitoring in real course contexts. However, sketching while studying appears to eliminate the illusions of comprehension caused by the varying presence of images. This finding extends prior work showing benefits of generative activities on metacomprehension, especially explanation (Fukaya, 2013; Griffin, Wiley, & Thiede, 2019; Jaeger & Wiley, 2014; Schleinschok et al., 2017; Wiley et al., 2016).

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