The Role of Refutation and Surprise in Addressing Misconceptions
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Background
Students offer develop misconceptions about the world that fit a naive understanding of a concept, but differ from a scientific understanding (Vosniadou, 1994). To successfully overcome a misconception, students must become aware of the contrasts and inconsistencies between their naive theories and the correct scientific theories (Broughton & Sinatra, 2010).

Refutation texts have been effective for reducing misconceptions (Broughton & Sinatra, 2010) because (relative to traditional expository texts) they draw learners’ attention, activate their prior knowledge, and help them notice their cognitive conflicts (Kendeou & van den Broek, 2007).

Another reason that refutation texts might be so effective is that they generate surprise. Previous work on learning from errors has shown that surprise activates stronger when more errors were made (Wessel et al. 2012) and misconceptions held with high confidence were more likely to be corrected than misconceptions held with low confidence (Eich et al. 2013; Metcalfe, 2017).

Research Questions
1. Do students learn more from a refutation text than an expository text?
2. Do refutation texts elicit more surprise and/or confusion than expository texts?
3. Does surprise predict learning? Does it interact with other responses such as confidence and confusion?

Design & Procedure

Materials
Two versions of a lesson on the causes of the seasons. They differed only in the first paragraph (shown below).

Refutation Text:
“Many people believe that the changing seasons are the result of the Earth being closer to the Sun during the summer months and farther away from the Sun during the winter months. Perhaps you hold similar beliefs. However, seasons do not change because the distance between the Earth and the Sun change. In fact, Earth is closer to the Sun in winter and farther away from the Sun in summer. Seasonal change is the result of two features of the Earth: its tilted axis and its elliptical orbit around the Sun…”

Expository Text:
“From your own experiences you know that the seasons change throughout the year. Depending on the latitude where you live, the temperatures may vary from hot to cold. The changing seasons on Earth are the result of two features of the Earth: its tilted axis and its elliptical orbit around the Sun. Earth is closest to the Sun in January (winter) and farthest from the Sun in July (summer).…”

Ratings of Surprise and Confusion
1. How surprising was the information in the text?
2. How confused are you about the cause of the seasons?

Test of Understanding
1. Explain why it is hotter in summer than winter.
2. Explain the causes for why the seasons change.
3. 10 multiple choice questions (2 versions)
4. How confident are you that you understand what causes the seasons?

Learning Results

Conclusions
• Participants learned from both texts, but the gain was greater for refutation than expository texts
• Overall benefit for refutation was driven mostly by a significantly larger decrease in misconceptions and a marginally larger increase in correct ideas
• There was no difference in ratings of surprise, confusion, or confidence between the two texts
• Surprise did not directly predict learning on any measure, but did interact with confusion to predict learning on Multiple Choice questions

Limitations & Future Directions
• Measures of surprise and confusion are general – future studies could ask what was confusing/surprising
• No measures of time on task – future studies could track and/or limit how quickly participants read
• Multiple choice questions are VERY hard (floor effects for some items) and could be redesigned

References