# **Exploring What Kinds of Questions Students Ask About Earth Science Data Visualizations**

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## Background

This study focused on types of questions students asked about earth science data visualizations, specifically maps. Based on previous question-asking research (Kastens, Zrada, & Turrin, 2019), this study sought to expand this work by investigating how earth science students' questions might evolve over the course of a semester.

The Next Generation Science Standards recently identified asking questions as an essential practice (National Research Council, 2012). Question-asking skills are critically important, both in scholarly and real-world settings. However, teacher – not student – questions are often the focus of research on question-asking in academic settings.

- This MUSE project aimed to investigate two main research questions: 1. What types of questions do earth science students ask about earth science data
- visualizations? 2. How do earth science student questions about earth science data visualizations evolve over the course of a semester?

# Methods

Twelve undergraduate students enrolled in an earth science course participated in this study; only four students returned to complete the post-assessment. At both the start and end of the semester. students explored maps within the Polar Explorer app and were prompted to ask questions about the data visualizations (maps) shown. Two sets of maps were utilized in this study: Why does sea level change? and Who is vulnerable? In addition, two question prompts were used: the first prompted participants to ask as many questions as



Figure 1. Polar Explorer app displaying a Human Impact map.

they could think of, while the second asked students to come up with questions they would ask a scientist who collected the data.

Student questions were analyzed qualitatively using an existing coding scheme (Kastens, Zrada, & Turrin, 2019). Questions were categorized into one of four categories: (1) questions about the data; (2) questions about the earth; (3) questions about the app; (4) not categorizable. Question categories were further divided into sub-categories, resulting in more specific question categories such as *Questions about the data > How was data collected?* 

Question sub-categories corresponded to a level of Bloom's taxonomy; this strategy was used to measure question level. For example, a question in which a participant generated their own hypothesis is a high level question (corresponding to the highest Bloom's level – create)

# Coding

New coders were first trained on the coding scheme, completing eight rounds of practice coding (50 questions per round). In each round, three coders categorized questions individually, then the team collectively reviewed and discussed codes to reach agreement. After completing these eight training rounds, the team achieved greater than 50% reliability and began to code the study question data. Three coders independently coded ten sets of 20-22 questions, meeting to discuss and reconcile any inconsistencies after each set.

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# Results

On average, participants asked fewer questions at the end of the semester compared to the beginning of the semester. This finding held true when looking at all participants at pre and post (Figure 2) as well as only returning participants at pre and post (Figure 3).



Figure 2. Average number of questions all participants asked at the beginning and end of the semester.

To better visualize the differences in the number and types of questions returning participants (N=4) asked throughout the semester, Figures 4 and 5 represent questions asked at the pre and post assessments, further broken down by the question prompt (Ask a Scientist or Many Questions).



Figure 4. Number of questions participants asked during the Ask a Scientist prompt, categorized by Bloom's level.

Figures 6 and 7 represent questions asked at the pre and post assessments, based on map set (Why does sea level change? or Who's vulnerable?).



Figure 6. Number of questions participants asked about *Why does sea level change?* maps, categorized by Bloom's level.



Figure 3. Average number of questions returning participants asked at the beginning and end of the semester.

Figure 5. Number of questions participants asked during the *Many Questions* prompt, categorized by Bloom's level.



Figure 7. Number of questions participants asked about Who's vulnerable? maps. categorized by Bloom's level.

data is displayed in Figures 3–7.

Overall, lower level Bloom's questions (e.g. understand, apply) were more frequent than higher level Bloom's questions (e.g. evaluate, create). Participants did not ask more higher level questions on the post-assessment, although this was the hypothesized outcome. Another surprising result was the increase in number of non-questions at postassessment. Since all participants had taken an earth science course that semester, this decline in question-asking about earth science data was unexpected.

**Limitations.** From the start, a major limitation of this study was the small number of participants at pre-assessment (N=12). Since so few students returned for the postassessment (33%), it is difficult to draw any real conclusions from this data; one cannot generalize the results of this study to the greater population. A larger-scale study with more participants is necessary to draw conclusions.

In addition, this study was impacted by COVID-19. Participants completed the preassessment in a controlled laboratory setting on an iPad. However, participants were required to complete the post-assessment outside of this laboratory environment using a device that they had available (e.g. computer). This major difference in pre and post experiences is problematic.

Future Directions. Moving forward, this study will be run on a larger scale with more participants. Ideally, all participants will experience a uniform experimental setting - an inperson laboratory study utilizing an iPad to access the app.

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## Conclusions

Among returning participants (N=4), students asked fewer questions on average at the end of the semester when compared to the beginning of the semester. Only returning participant

# References

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