Towards Understanding Group Collaboration Patterns Around Mobile Augmented-Reality Interfaces for Geospatial Science Data Visualizations

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Motivation

- **Mobile Augmented Reality (AR)** has been used to support **collaborative learning** through **geoscience data visualization** [1].
- However, little is known about how student **groups naturally collaborate** around mobile-AR applications to interpret and make sense of geodata visualizations in a classroom setting.

Research Goal

The aim of the study was to **understand** student groups' **natural collaboration behaviors** when **exploring geo-spatial data visualization** within a **mobile-AR application** through a design probe study, including behaviors of:

- **Gestures Interaction Patterns**: gestures employed by participants when interacting with our prototype (e.g., drag, rotate).
- **Group Talk Categories**: how and what participants were talking about (e.g., content talk or how-to talk) [2, 3].
- **Collaboration Profiles**: different verbal and physical behaviors employed by groups during collaborative science data exploration (e.g., turn-taker, driver-as-a-guide) [2, 3].

Methodology: Design Probe Study

- **14 pre-service teachers**, **7 groups** (2 per group).
- All participants had completed an introductory Earth Science class.
- All participants completed **3 tasks** of exploring sea-surface and coral reef geodata visualizations across space and time using our prototype (Figure 1).
- 2 researchers qualitatively coded 7 videos based on **30-second segments**. In total, **80 segments** were included in our data analysis (58 excluded).

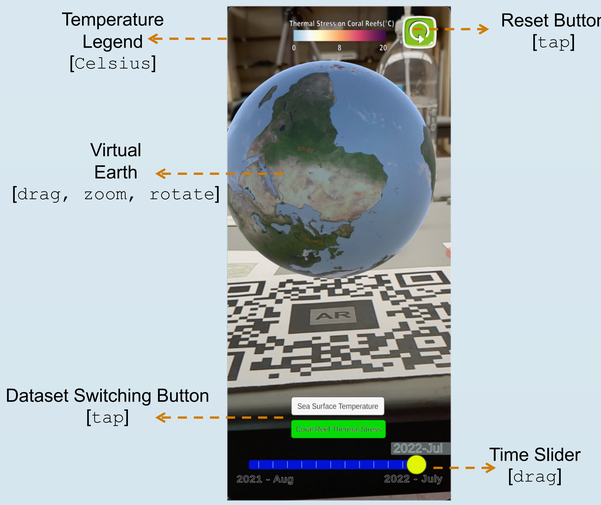


Figure 1: Our Mobile-AR Prototype Application for Geospatial Data Visualization of Earth's Ocean System.

Findings

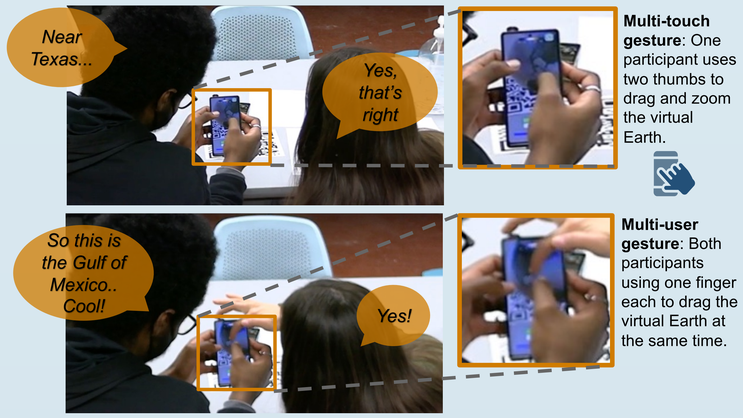
Six **talk categories** were coded, including Content talk, Group-process talk, Combination, How-to-talk, No talk, and Off-topic.

- **Content talk** (51.25%) (Figure 2) and **Group-process talk** (21.25%) are the top-two most frequent categories.

Figure 2: Example of Group Episode Coded as Content Talk [G463-1].

Five **collaboration profiles** were coded, including Driver-as-a-Guide, Turn-Taker, Driver-Navigator, Independent, and Driver-Passenger.

- **Driver-as-a-Guide** (45.00%) and **Turn-Taker** (31.25%) (Figure 3) are the top two most frequent collaboration profiles. Turn-taker has been shown to support effective collaborative learning [2, 3].



Multi-touch gesture: One participant uses two thumbs to drag and zoom the virtual Earth.

Multi-user gesture: Both participants using one finger each to drag the virtual Earth at the same time.

Figure 3: Example of Participants Employing Multi-Touch and Multi-User Gestures as Turn-Takers When Exploring Our Prototype [G724].

Our findings demonstrate the potential of mobile-AR applications to support effective group discussion and facilitate collaborative learning in the context of geospatial science data among pre-service teacher groups.

Design Implications and Future Work

- Analyzed participants' post-interaction **qualitative feedback** to inform design implications:
  - Participants expressed the desire to **link color of data visualizations with their respective numerical estimates on temperature legend** (e.g., tapping on colors to display temperature data, as shown in Figure 4).
  - We had a reset button that reset both the size and orientation of the virtual earth, but students rarely used it. Future work should explore **variable reset settings** in such gesture-based AR geodata applications (Figure 5).

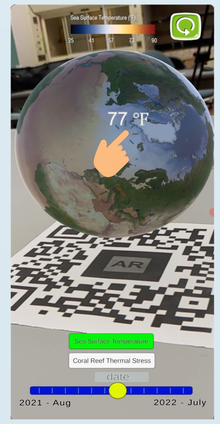


Figure 4: Example of Interactive Gesture (Tapping) Linking Visualization Color with Temperature Data.

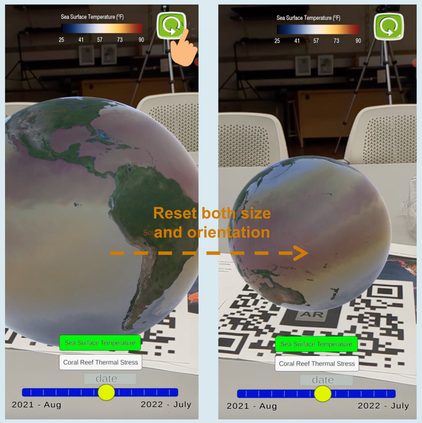


Figure 5: Example of Virtual Earth Before Reset and After Reset.

- We will update our mobile AR prototype based on the study feedback through a **user-centered design approach**.
- We are in process of **comparing** students' collaboration behaviors on **mobile-AR versus** a multi-touch **spherical display** (Figure 6) in the context of science data visualization.

Figure 6: Our Multi-touch Spherical Display Prototype, inspired by [3].

References

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