**BACKGROUND**

- Motion charts (A-Aziz et al., 2010; Rosling et al., 2005) are a new representational form for visualizing multivariate data through time.
- This free digital tool, along with public "datasets," are widely used through Gapminder’s website (gapminder.org).
- This design study treats Gapminder motion charts as Big Data visualizations, producing STEM arguments that increasingly appear in public media.
- Modeling the wealth and health of nations invites secondary mathematics curricula students to take a new perspective on mathematical literacy.
- How do prospective math teachers make sense of this modeling activity?

**DESIGN**

- Larger design study (Cobb et al., 2003) asked students to interpret, remix, and make their own "interesting" motion chart graph arguments using Gapminder.
- Setting: Required Mathematics Literacies course for undergraduates and master’s students attending an elite university in the South.
- Timeline: Activities spanned three 3-hour classes over four weeks of the semester. Data reported come from DIY activity during last 70 minutes of second class meeting.
- Focal participants: The course instructor identified two student pairs for selective case study comparison (Heyd-Metzler, 2006): Masters students Nathan and Nicole and undergraduates Cara and Tara. We considered all students as non-experts in the creation of graph argument performances (as compared to Gapminder’s designer, Hans Rosling).
- Data Collection: Single HD video record of each student pair working at a table with two computers. Analysis focuses on multi-modal activity of modeling (talk, significant gesture, and interaction with the computer and Gapminder display).

**ANALYSIS**

**QUESTION 1: How do student pairs’ "graph argument paths" compare as a modeling activity?**

We segmented 70 minutes of video data for each pair using the following rules:
- A model is a unique pairing of X- and Y-axis indicators selected from the "dataset" and explicitly mentioned in talk.
- Links are transitions from one model (node) to the next. "Playing" that model displays changing indicator values through time.
- Numbers in nodes show how often student(s) examined a model.

**QUESTION 2: When students’ "mindsets" do not match Gapminder’s "dataset" (Rosling, TED talk at US State Department, 2005), how do trouble/repair sequences (Schemloff, 1991) drive model refinement?**

We used interaction and conversation analysis (Jordan & Henderson, 1995; Perry et al., 2010; Schemloff, 1991) to explore the sequential organization of trouble and repair as student pairs constructed models using Gapminder. Micro-analysis is complete for the first 10 minutes of the video record for each group.
- Trouble when "mindset"-"dataset" animates different worlds (Tool, Quantity & Measures, Wealth & Health)
- Repair re-aligns these worlds (we conjecture) and refines a model under construction.
- Gapminder (dynamic visualization tool) makes contributions in conversation.

**FINDINGS**

**FINDINGS LEVEL 1 ANALYSIS**

- Very different patterns of collaboration with single vs. two modeling environments; leads to coordination for C&T whose models are in sync only once (Government Health Spending, Life Expectancy).
- Different use of tool’s dynamic feature N&N regularly “play” models while C&T mostly treat display as static scatter plot (i.e., conventional school statistical display).
- Both worked serially through a selection of indicators for X- and Y-axes.
- N&N show extended periods of progressive model refinement (Collins, Joseph, And Bietacz, 2004, e.g., returning to (Income per person, CO2 Emissions) 7 times. C&T never return to a model.)
- Collaborative refinement in a common modeling environment supports successful graph arguments (e.g., C&T leave the DIY without a graph argument).

**FINDINGS LEVEL 2 ANALYSIS**

- C&T do not consider time, so do not think developmentally about health and wealth of nations.
- N&N build model in order to show developmental influence over time.
- C&T reach model path impasses, and abandon models in the face of trouble.
- N&N pursue trouble by considering related indicators, contrasts between countries, and research outside Gapminder.
- The worlds animated in trouble and repair remain puzzling to us—we need to go deeper on what constitutes a “signal” in the dynamic visualization of the health and wealth of nations.

**NEXT STEPS**

- Extend micro-analysis across entire DIY modeling effort for each group.
- Consider hybridity of animated worlds (Ochs et al., 1996) in analysis of trouble and repair sequences.
- Analyze focus group interviews after the design study to relate their different values regarding “what counts as mathematics” in Gapminder motion chart graph arguments.
- Do student’s “mindsets” about mathematical literacy correspond with our (and our programs’) conception of “productive disciplinary engagement” (Engle, 2002)?