"What in the world?" Animated Worlds in Multivariable Modeling with Motion Chart Graph Arguments

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Abstract: This poster presents part of a design study that engaged prospective secondary mathematics teachers in multivariable modeling practices to support learning about critical mathematics and statistical literacies. Student pairs constructed graph arguments about global development using an online, dynamic graphing tool (motion chart). Interaction analysis of sequences of student trouble suggests that animating representing and represented worlds and laminating historical narratives to the mathematical display encouraged success in the activity.

Motion Charts, Modeling and Mathematical and Statistical Literacies

The motion chart (Al-Aziz, Christou, & Dinov, 2010; Rosling, Ronnlund, & Rosling, 2005) is a new, dynamic, digital, representational form for modeling multivariate data over time, freely available, along with large public datasets, on Gapminder's website (gapminder.org). This study treats motion charts as comparable in nature to complex, Big Data visualizations used to produce STEM arguments that increasingly appear in public media spaces. A discussion of mathematics and statistics in the world thus framed the Gapminder activities. We hoped that positioning secondary mathematics teachers as consumers and authors of arguments with motion charts about global development would push them to build upon their reading of Gutstein's (2003) contrast of critical and functional mathematical literacies and to consider "reading and writing the world" using models.

Accordingly, how do prospective math teachers make sense of this modeling activity? Applying Ochs, Gonzales, and Jacoby's (1996) framework for how laboratory physicists animate different worlds in talk to construct models to describe physics experiments, we contend that successful modeling practices with motion charts (constructing and evaluating graph arguments that explain and compare nations' development trend lines) depend on the animation and lamination of relations between represented (global health and wealth) and representing worlds (the tool and datasets) (Gravemeijer, 1994; Hall, 2000). We seek to explore at the microanalytic level of multimodal, sequential interaction an emerging practice of modeling that accounts for how students used Gapminder to animate complex, multidisciplinary, multivariable data and bind a crafted narrative of historical change to a dynamic, mathematical display to compose a compelling graph argument.

Theoretical and Methodological Approaches Pursued in the DIY Activity

The modeling task was part of a larger design study (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) in a required Mathematics Literacies course at an elite university in the Southern U.S., spanning three 3-hour classes over four weeks. We first asked students to find and dissect mathematical or statistical arguments in public media. We then introduced students to Hans Rosling's (Gapminder's designer) Gapminder performances. Students then used Gapminder to imitate and remix Hans' arguments and to make their own graph arguments in a DIY activity to perform in the next class. Data reported come from the DIY activity in the last 70 minutes of the second class. The course instructor identified two student pairs for selective case study comparison (Flyvbjerg, 2006): masters students Nathan and Nicole (N&N) and undergraduates Cara and Tara (C&T). We considered all students as nonexperts in graph argument performance creation (as compared to Hans). We captured a HD video record of each focal pair working at a table with two computers.

Trouble with "Interestingness" in Animating and Storify-ing Worlds

Analysis focuses on the multimodal activity of modeling (talk, significant gesture, interaction with computer(s) and Gapminder display). Initial structural analysis segmented the 70 minutes of video data for both student pairs in order to compare their *graph argument paths*, following their transitions between models, each defined as selection of a unique pairing of X- and Y-axis indicators from the dataset and unambiguously mentioned in talk. We considered whether or not students *played* the graph so that the model displayed changing indicator values through time and how often student(s) examined a given model. We compared three model paths: one for N&N who worked on a single computer, one for C, and one for T, who worked side by side on separate computers.

We then used interaction and conversation analysis (Jordan & Henderson, 1995; Schegloff, 1991) to explore the sequential organization of trouble and repair in these model assembly pathways as student pairs continually generated models using Gapminder. We identified three categories of trouble: (a) when a country's trail violated expectations (e.g., increase in life expectancy with an increase in alcohol consumption); (b) when tool unfamiliarity left stories untold (e.g., forgetting to select country trails to show change over time when playing the graph), or (c) when there was confusion with quantities (e.g., CO^2 per person vs. yearly CO^2 emissions). Next, using patterns of students' announcements of trouble, we delved into animation and lamination in student talk (at the level of predicate structures) and gesture. We looked at the ontologies of story fragments related to health and economic processes unfolding. As in Ochs et al.'s (1996) analysis of physicists, we conjectured that Gapminder modelers hybridize stories of country development with a visually, dynamic graph to collaboratively and progressively build and refine (Collins, Joseph, & Bielaczyc, 2004) what they feel are "interesting" models for public performance. While the larger corpus of data has been reviewed with this analytic framework, a detailed microanalysis and transcription is complete for the first 10 minutes of each video record and for a second 10 minutes when each pair approached a model close to the final graph argument presented in class.

Preliminary Findings and Discussion

This study offers new insight into how prospective secondary math teachers variably understand a novel genre of modeling practices as a critical mathematical literacy. Though both pairs worked serially through indictors for X- and Y-axes, selected 'interesting" variables that were personally relevant, socially taboo or trendy, determined model misfit (i.e., an "uninteresting" display was unfit for this task), and argued about alternative variables and measurements, the comparative analysis of model paths showed little collaborative progressive refinement (Collins et al., 2004) for C&T as compared to N&N (e.g., N&N often returned to models while C&T never revisited a model). N&N activated and aligned the represented and representing worlds of motion charts, as evidenced by the ways in which they communicated understandings of quantities and the graphing tool, engaged in historical inquiry to contrast and explicate relationships between health and wealth of nations, and explicitly considered development over time by regularly playing models. Similar to Ochs et al.'s (1996) physicists, N&N used hybrid utterances to describe and narrate the graphical representation. Indeed, the motion of the motion chart afforded N&N possibilities for seeing and telling historical, social, economic narratives based on power relations. Their common modeling environment (one screen), which helped N&N focus their model path, also likely supported their productivity. In contrast, C&T's division of labor across separate modeling environments (two screens) led to diverging model paths, model abandonment and less consistent and frequent engagement in the animation of worlds. As they moved from model to model, especially at the start of the DIY, C&T did not regularly play the world, which restricted their capacities for animating explanations, for considering change over time, and for embracing the tool's "messiness"—its dynamic and multivariable qualities (e.g., they mostly treat the display as static scatter plot, like a conventional school statistical display). Such a stance, akin to a functional mathematical literacy perspective, created challenges for describing the graph animations narratively to compare varying historical anecdotes of development for particular nations. Additional analysis will continue to describe the processes of animation and lamination of conceptual worlds to support deeper connections between this new domain of modeling practices and critical mathematical literacies.

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