Investigating Scientific Practices from NGSS and ISE Settings During Meaning-Making from Global Spatial Data Visualizations

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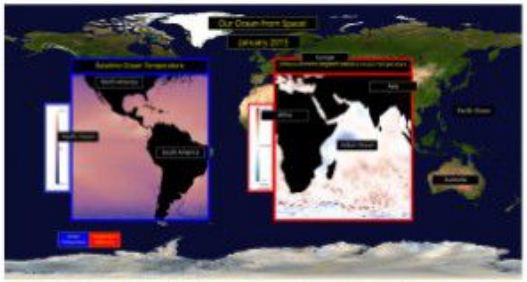

TIDESS project tabletop prototype. Blue box outlines baseline ocean temperature data, red box outlines sea surface temperature anomaly data. Courtesy TIDESS project.

Educators in various learning contexts harness global data visualizations to share real, contemporary scientific data with learners as they grapple with ocean issues such as climate change and increased demand on fisheries as we feed a burgeoning world population[1]. **The Next Generation Science Standards[2] outline eight practices that describe scientific behaviors during investigation of the natural world. Researchers in informal science learning institutions outline scientific practices as:**

1) part of strands of science learning for the field[3],
2) principles for and evidence of effective exhibit design for learning in informal science education institutions[4], and
3) previous practical evaluation-based practices specifically seen in interactions with exhibits of global ocean data visualizations, such as including prior knowledge and experience[5].

Our research describes how these practices fit together with NGSS practices and fit into the framework of Barriault and Pearson (2010) for levels of engagement: initiation, transition, and breakthrough behaviors.

1. Robinson (2016)
2. NGSS Lead States (2013)
3. NRC (2009)
4. Barriault & Pearson (2010); Hauan, et al. (2017); Hohenstein & Tran (2007); Horn et al. (2012)
5. Rowe et al. (2010); Stofer (2016)

Table 1. Example codes from data visualization study aligned with NGSS practices and ISEI learning research

	Previous Literature					
NGSS practice	Informal Learning Strand	Horn et al.	Hauan et al.	Barriault and Pearson level	Authors' Code	Example
Planning and Carrying out investigations	2 - Come to … understand, … concepts, … related to science	Paraphrasing exhibit text	Talk	Initiation	Mention Color, time, or labeled geography	"Where it is blue, it is cooler than it would normally have been." Group 724
Obtaining, Evaluating, and Communicating Information	2- Come to … use … facts related to science	Content talk (general)	Commenting on content	Transition	Identify unlabeled location or share prior knowledge	It's warming up in the Gulf. The Gulf's been getting warm. Hurricane Alley." – Group 991
Obtaining, Evaluating, and Communicating Information	4 – Reflect on science … and their own process of learning	Reflecting on learning	Testing individually/ socially	Breakthrough	Reflecting on learning	"Now I get it." – Group 475; "So from what I understand …" – Group 887
Planning and Carrying out Investigations	3 – Manipulate, test, explore … the natural and physical world	N/A	Suggestion or Asking question	Breakthrough	Make Predictions	"Yeah because … after September … it's gonna start cooling down again, so let's see." – Group 597
Analyzing and Interpreting Data	2 – Come to generate … explanations …	N/A	Observation of phenomena	Breakthrough	Make Comparisons	"ok so that means it's colder down here and hotter above." – Group 765
Engaging in Argument from Evidence	5 Participate in scientific activities …	N/A	Commenting on other students' talk or actions	Breakthrough	Refining Understanding	P1: Oh I wanna see how cold it is in December. Hmm! Pretty cold. P2: Not as cold as January and Feburary. P1: Yeah. It's kinda weird. December is, I think is the coldest month. – Group 293

Family group interacts with TIDESS tabletop prototype during lab study. Courtesy TIDESS project.

We coded examples of what we deemed *use of scientific practices* based on utterances of 11 family groups (one or more adult with one or more child, 2-4 total participants each) responding to task prompts in a lab study of a tabletop data visualization exhibit.

National Science Foundation
#DRL-1612485

While we saw evidence of these practices in use by many groups, not all groups used all practices. Reflecting on their own learning, in particular, was not very common. Also, these were the researchers' labels of the use of practices. We do not know whether the participants themselves recognize these as *practices* let alone as *authentic practices that scientists use in their work*.

By recognizing the alignment of NGSS practices with those studied in informal learning settings, we can search for these practices in a variety of educational programs. Additionally, by presenting them in a hierarchy such as that of Barriault and Pearson (2010), we can begin to assess these settings and programs for deeper engagement of participants.

Future exhibits could feature data visualizations in native projections, such as on a sphere. Courtesy TIDESS project.

Finally, **by understanding which scientific practices are most abundant and most like experts', we can design tasks and scaffolds to support learning how to use these practices most expertly** in tasks with data visualization meaning-making.