"I Did Not Think We Did That Much Twists": Using Video to Reanimate Embodied Experiences for Use in Scientific Discussions

Katherine C. Chapman, Vanderbilt University, k.chapman@vanderbilt.edu

Abstract: This analysis looks at the potential for video with GPS-enabled data displays to act as a boundary object between everyday and scientific ways of knowing. Video records with complex data displays show potential for facilitating this connection in interest-driven environments by reanimating embodied experiences and thus making them part of sensemaking processes rather than merely the object of those processes.

Background

The influence of anthropological ideas in education research has prompted scholars to look at people's experiences with math and science in non-traditional settings such as selling candy (Saxe, 1988), shopping for groceries (Lave, 1988), playing on a basketball team (Nasir, 2000), tithing (Taylor, 2013), and many others. Most if not all of these studies document a significant disconnect between the kind of math performed in school and the kind performed in these more everyday settings (e.g. Carraher et al, 1985). One consequence of this work is that scholars have begun to consider learning as a cultural process, and specifically as one that often takes place at the confluence of two or more cultures. In equity work, this generally surrounds the cultures of "home" and "school." Given the extent to which the practices of K–12 schooling in the U.S. have tended to reflect those of the White middle class (Lortie, 1975; Mehan, 1979; Levinson et al, 1996), designing to address this cultural disconnect is conjectured to support students from minoritized backgrounds. In science, technology, engineering, and mathematics (STEM) learning, the two cultures are more often everyday and academic or professional versions of STEM fields (e.g. de la Rocha, 1985; Knorr Cetina, 1999). While some of these scholars focus on the "misconceptions" that students bring to science classrooms, others (e.g. diSessa, 1996; Nemirovsky et al, 2004) have highlighted the relatively coherent nature of pre-schooled ideas about science and math, and considered how to build on them toward a more generally accepted scientific conception. In some cases, connecting to home practices is considered "a way of motivating students" (Moje et al, 2004, p. 44). In other work, however, connecting to "everyday" practices—particularly those that involve large-scale bodily movement (e.g. Ma, 2016)—is theorized to have a qualitative impact on developing disciplinary concepts.

Context

The broader study from which this analysis derives focuses on a week-long summer camp (U.S. grades 4–5) where students participated across two parallel learning sites: a living museum dedicated to maritime heritage, in which the students learned to rig and sail small boats in pairs, and an informal science institution, in which students investigated some of the principles of weather and physics that might help them in their sailing. Broader research questions for the camp were about the extent to which each half contributed to the other—that is, whether the science portion helped students learn to sail, or conversely whether experiences in boats helped them think about the physics of sailing. At the broadest level, the answer to that question was largely "no"—consistent with the literature, for the most part the students did not appear to experience either half of the camp as being particularly relevant to the other. One exception to that was the focal episode presented here, in which students were shown an excerpt of the research footage with various GPS-enabled displays and asked to try to use that footage to determine where the wind was coming from.

Theoretical and conceptual frameworks

Many scholars have looked into the relationship between children's use of everyday knowledge and its relationship to scientific concepts, and specifically to instruction (e.g. DiSesssa, 1996; Inagaki, 1990; Panofsky et al, 1990). I take a view that foregrounds how knowing is not only influenced by prior knowledge and experience, but is mediated by the technological and social contexts of learning (Carraher et al, 1985; Vygotsky, 1986; Saxe, 1988; Nasir et al, 2008). More specifically, I am interested in how learning takes place at the confluences of two or more knowledge communities. Studies on boundary crossing (for an overview of this work, see Akkerman & Bakker, 2011) suggest several points about this type of learning. For this analysis, I draw on two in particular. First, boundaries as borderlands between two sociocultural spaces (rather than merely borders) imply both continuity and discontinuity. Second, boundary objects—objects that function as bridges between two sociocultural spaces—"both inhabit several intersecting worlds and satisfy the informational requirements of each of them. . . . [They are] both plastic enough to adapt to local needs and the constraints of the several parties

employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use" (Star & Griesemer, 1989, p. 393).

Focal episode

The analysis presented here is opportunistic—the focal episode was not part of the initial curriculum or study design, but emerged from students' own reactions to data collection and the availability of novel data displays. Data collection included mounting GPS-enabled cameras on the sailboats. While this footage was originally intended for researcher use only, on day four, students watched some of the resulting footage as part of a discussion about sailing upwind.

Students were shown video of themselves, taken from the top of the mast of one of the boats, and overlaid with GPS-enabled information about their speed and direction (see Figure 1b). The top-down video was a record of their embodied experiences that also conveniently resembled the traditional inscriptions they had been working from (in the sense that both were top-down views of a single boat, see Figures 1a and b). The purpose of this analysis is to explore what evidence it may provide that such an episode is a useful pedagogical tool, and begin to make conjectures about how this tool might contribute to the next design iteration. In particular, I ask whether this episode offers any evidence of creating a "trading zone" between the science and sailing portions of the camp, and if so, how such a space might qualitatively contribute to the students' developing conceptions about how the boats work.

Data analysis

The entire pedagogical episode was transcribed from the room-level camera, and later supplemented with the student-level video of the focal student, both to provide a more complete transcript and to more clearly identify which utterances were hers. Next I used the constant comparative method (Glaser & Strauss, 1967), open coding all video-related utterances, grouping those into axial codes, and finally comparing emergent codes with relevant literature. Because of Starr and Griesemer's observation that boundary objects are "weakly structured in common use, and become strongly structured in individual site use" (1989, p. 393), I focused in on how the video was being treated—specifically, as what kind of object—and to what use it was being put. What emerged was a picture of qualitative differences between how the focal student and how the other students were using the video in service of the overall argument about wind.

Table 1: Examples of video being used as different kinds of objects

	Video as object	Video as record/index	Video as source of data
Making observations	"It's like the speed monitor and speed tracker"	"Look at my arm—look how uncomfortable that looks."	"Four's your slowest."
Inhabiting/Extrapolating	"Also, if you look at like the speed thermometer, it looks like it's gonna come down."	"I'm telling Amelia to rely on her fears." (comment not available in record, i.e. from memory)	"They were going south and I think the wind was coming south and they were going into it, because they were stopping"
Making value judgements	"You spelled 'quick' wrong"	"Aw, my steering was terrible that day."	

Preliminary findings

All students were engaged in a lively evidence-based debate about the target question, Where is the wind coming from and how do you know? While the video was a record of a personal experience all of the students had shared just two days prior (though focused on two students), it was also framed by the instructor as being a potential source of data about wind direction. There were therefore three major ways the students treated the object: 1) as an object in its own right, most generally a computer display with certain visual features; 2) as a record of—and index to—a personal experience; and 3) as a source of data. Similarly, there were three general categories of actions students took towards these objects, making observations about or inferences from them, and occasionally making value judgments.

Group discussion progressed from making observations about the video as object (i.e. pointing out where the data displays were, and what they showed) to making inferences about what could be seen in the video that

might bear on the question (e.g. claiming that the wind was not coming from the south, because when they were facing south they were still moving). Several students made observations based on the data displays (e.g. pointing out that 3mph was the slowest) and several made inferences that compared the data displays at different times (e.g. "When they were going to the south, they were going slower"). Though it is beyond the scope of this analysis to make claims about the merits of the students' arguments, coordinating multiple pieces of information and drawing inferences is generally taken to be more sophisticated than making simple observations (e.g. Berland & Reiser, 2011; Walsh & McGowan, 2017).

The student who appeared in the focal video, however, was the only one who appeared to use the video to reanimate her own experiences in the boat, which she was then able to draw on as part of the discussion. She repeatedly made references to information not available in the record, such as narrating moments when she remembered trying to help her sailing partner to calm down ("I'm telling Amelia to rely on her fears"). She was also the only student to compare the video representation directly to her memory of the experience: presented with the display indicating their path over time (see figure 1b) she exclaimed, "I did not think we did that much twists." Several times she attempted to direct others' attention to these aspects of the video, saying things like, "Look at my arm, though, look how uncomfortable that looks." She also coordinated across all three versions of the object, when she noted (based on the movement of the icon across the average speed line), "We're gonna get a huge gust of wind in just a sec," thus coordinating the data display across time with the image as indexing herself in a boat, and drawing an inference from it (that a jump in speed might indicate a gust of wind).

These differences in the focal student's contributions to the discussion are not only notable, they are potentially important for scientific sensemaking for three reasons. Most importantly, they provide evidence of the intended coordination between the experiences in the boats and those of the physics discussions—coordination that was assumed by the designers to happen throughout the camp, but was only seen explicitly in this discussion. Beyond that, there is some evidence that this is a more expert practice for sailors—when the head sailing instructor was shown the same video, she made explicit attempts to draw inferences based on her sailing experience and knowledge of the local context that were not necessarily available in the record. Finally, while limiting the information to the elements most students paid attention to—the GPS trail and the compass heading—might produce something closer to a simple school-based story problem, the video as boundary object offered a broader range of semiotic resources (Wisittanawat & Gresalfi, under review). Including information such as the affective experience of the person running the sail not only provides students with opportunities to determine the salience of different kinds of data, but potentially provides information necessary for more careful analysis of the system.

Discussion and next steps

The sailing portion of camp was turned into an object for observation by creating and then displaying video of it in the science portion. In keeping with the norms of the science part of camp, the particulars of the video were treated as exemplary versions of more general phenomena that were thereby made available for study. Arguably, then, the "video as display" was a necessary feature for the objectification of the experience of sailing into the project of science, though the "video as source of data" was the more traditionally science-y treatment. Nevertheless, the video was also a record (and index) of a personal, embodied experience that belonged to the students and provided not only a personal link to the phenomenon, but potential access to further data about the behavior of the boats.

In this discussion of the video, students were participating across all three of these planes. Generally, they used the video as display to build to using video as data source. But the focal student was also able to build a bridge from video as index of personal experience to video as data source, thus completing the connection between the two halves of camp. I argue, therefore, that this video was able to act as a boundary object between the sailing and the science.

The camp was premised on the idea that aspects of sailing could be legitimate content for discussions about physics. It was not until the video display, however, that this potential was realized at a personal level for students. The weak structure of the object lent itself to both recall of sailing—bringing that experience into the science arena—but also the recontextualization of that experience as potential data for making more general arguments. Since the reanimation of experiences was different for students who appeared in the focal video, this suggests that future designs would benefit from offering more video of different students for this kind of public display and thinking more concertedly about other potential boundary objects for facilitating this coordination across contexts.

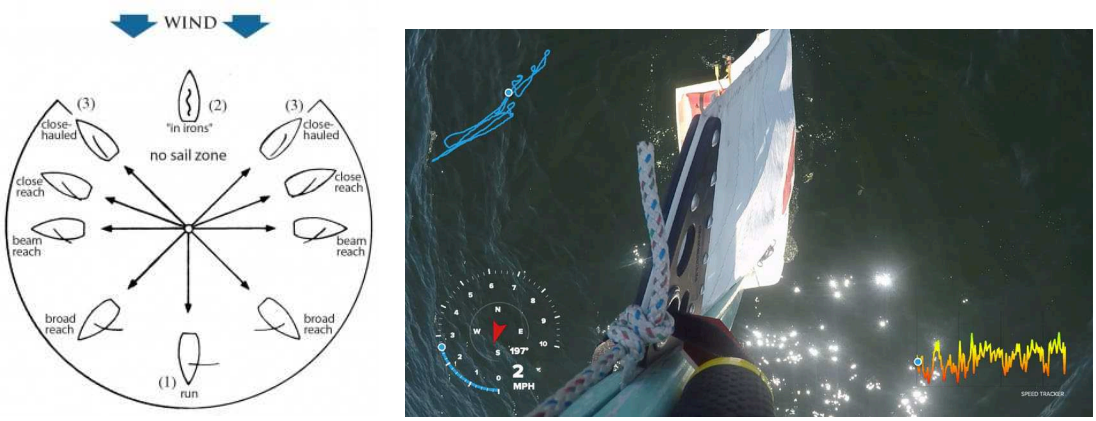

Figure 1. a (left) Typical "points of sail" diagram, retrieved from learnsailing.com
b. (right) Screenshot of top-down video showing GPS displays, as shown to students.

References

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of educational research*, *81*(2), 132-169.

Berland, L. K., & Reiser, B. J. (2011). Classroom communities' adaptations of the practice of scientific argumentation. Science Education, 95(2), 191-216.

Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in schools. *British journal of developmental psychology*, *3*(1), 21-29.

diSessa, A. A. (1996). What do "just plain folk" know about physics. *The handbook of education and human development: New models of learning, teaching, and schooling*, 709-730.

Glaser, B. G., & Strauss, A. (1967). Discovery of grounded theory: Strategies for qualitative review.

Howe, A. C. (1996). Development of science concepts within a Vygotskian framework. Science Education, 80(1), 35-51.

Inagaki, K. (1990). Young children's use of knowledge in everyday biology. *British journal of developmental psychology*, *8*(3), 281-288.

Lave, J. (1988). Cognition in practice: Mind, mathematics and culture in everyday life. Cambridge University Press.

Ma, J. Y. (2016). Designing disruptions for productive hybridity: The case of walking scale geometry. Journal of the Learning Sciences, 25(3), 335-371.

Nemirovsky, R., Rosebery, A. S., Solomon, J., & Warren, B. (Eds.). (2004). Everyday matters in science and mathematics: Studies of complex classroom events. Routledge.

Nasir, N. I. S. (2000). "Points ain't everything": Emergent goals and average and percent understandings in the play of basketball among African American students. *Anthropology & Education Quarterly*, *31*(3), 283-305.

Panofsky, C. P., John-Steiner, V., & Blackwell, P. J. (1992). 10 The development of scientific concepts and discourse. *Vygotsky and education: Instructional implications and applications of sociohistorical psychology*, 251.

Saxe, G. B. (1988). Candy selling and math learning. *Educational researcher*, *17*(6), 14-21.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations" and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. Social Studies of Science, 19, 387–420.

Vygotsky, L. (1986). Thought and language (A. Kozulin, Trans.). Cambridge, MA: Harvard University Press.

Walsh, E. M., & McGowan, V. C. (2017). 'Let your data tell a story:'climate change experts and students navigating disciplinary argumentation in the classroom. International Journal of Science Education, 39(1), 20-43.

Wisittanawat, P. & Gresalfi, M. (under review). The "tricky business" of genre blending: Tensions between frames of video game play and school mathematics.