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Curricular Reorganization in the Third Space: A Case of Consequential Reasoning around Data

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Abstract: Writing Data Stories is a social design-based research project to co-design and study data literacy units. The project encourages nondominant students to integrate everyday practices and scientific datasets by using storytelling and computational transformation to highlight personally and socially relevant issues. We present an analysis of one cycle of instruction where students pursued an unanticipated path of investigation—locating themselves on a map within a data analysis tool though the dataset lacked geographic information. A researcher initially considered this path to be unproductive, but changed focus as the teacher followed students' lead and encouraged exploration of the map in subsequent classes. Using conceptions of third space, we examine the sequence through which teachers and students co-produced a reorganization of the activity and power relations toward expansive data reasoning. We contrast this productive reorganization with marginalization of other student practices, identifying implications for curricular design and classroom research.

Keywords: data reasoning, third space, consequential learning, social design-based experiments

Introduction

Work exploring the importance, emergence and design of *Third Space* (Gutierrez, 2008; Gutierrez & Jurow, 2016) has centered primarily on supporting nondominant youth in informal learning contexts. In these informal contexts, educators have more flexibility than classroom teachers, and power relations between those involved—students, informal educators, researchers, and classroom teachers—tend to be more fluid. In contrast, in the vast majority of formal schooling contexts, students and classroom teachers must contend with institutional constraints of content standards and testing, without adequate support for more expansive approaches. Despite these challenges, the concept of Third Space has been used in school settings. For example, Gutiérrez et al. (1999), examined how teacher and student talk and knowledge in a science classroom were reorganized to create opportunities for authentic interaction and a shift in the social organization of learning. Like Gutiérrez et al.(1999), our work is also focused on Third Spaces in science classroom contexts. Using a design-based approach,we examine how student interests and exploration can drive curricular design and mediate a reorganization of student, teacher, researcher relations.

It is well recognized that STEM classrooms are often not supportive or encouraging spaces for nondominant youth (Martin, 2013; Bang, Warren, Rosebury, Medin, 2012). Prior research has used a Third Space lens on STEM in formal contexts, including work that has explored the merging of students' cultural repertoires of practice and social worlds with conventional STEM disciplines/practices (Barton & Tan, 2009), and that has focused on the development of relevant or relatable content (Barton, Tan, & Rivet, 2008; Moje, et al, 2004; Vick 2018). In our conceptualization, Third Space functions as a collective zone of proximal development (Gutiérrez, 2008; Vygotsky, 1978) or ZoPED (Griffin & Cole, 1984) wherein students and teachers co-construct knowledge in ways that reorganize the relation of everyday concepts and practices with scientific ones (Gutierrez & Jurow, 2016). In the context of design, the aim of supporting the emergence of a Third Space is to leverage resonances between scientific and everyday knowledge and practices that elevate nondominant students as sensemakers.

The Writing Data Stories project ("WDS"; IIS-1900606) seeks to develop and study curricular units that reposition the everyday knowledge and practices of youth of nondominant communities by placing that knowledge in direct conversation with scientific datasets and analytic practices such as data visualization, data transformation, and storytelling. A distinguishing principle in our work is understanding Third Space as a significant disruption to and reorganization of intellectual space, including a reorganization of what ideas and practices are valued, how they are linked, and whose linguistic and epistemic practices are privileged. Specifically, the project seeks to reconfigure students' relationships to data, which is often presented as an objective representation of reality that is granted higher epistemic status than other ways of knowing, including students' own experience (Bang and Medin, 2010). The project aims to elevate and weave the experiences of students from non-dominant communities *alongside and integrated into* scientific datasets, through students' use of

computational "data moves" (Erickson, Wilkerson, Finzer, & Reischmann, 2019) to inscribe their own knowledge, experiences, and values into the datasets (for example, by adding foods or variables such as cost, taste, or accessibility to a nutrition dataset). Our project goal is to make a significant contribution to the research on Third Space by studying and identifying consequential data literacy approaches for nondominant youth. A Third-Space-designed data literacy project must contest deficit discourses and disrupt rigid authoritative practices and ideas, highlighting social and cultural dimensions to "objective" pre-existing datasets. In this way, the project enables a reorganization of classroom roles and the relationships between everyday practices and disciplinary reasoning about data.

The case we share here offers specific insight into how learning in a Third Space de-centers authoritative views of STEM as data experiences were co-constructed by students, teachers, and researchers. Third spaces emerge in contexts with histories of practice, as well as in moment-to-moment activity. Our overall analysis focused on multiple moments in which the tools and goals of a particular lesson were reorganized in response to students' unexpected interests. In the analysis of the unfolding of this example, we highlight four phases of the reorganization and coproduction of this particular Third Space. The first phase entails a researcher-designed exploration activity that privileged everyday practices of students in collective knowledge production about the Common Online Data Analysis Platform (CODAP) and a nutrition dataset. The second emerged when students—afforded the open-endedness of exploration—reoriented toward map exploration and away from the nutrition dataset. The third phase occurred when the teacher, rejecting the researcher's initial advice, responded to students' unexpected interest in the map by reframing the exploration task to explicitly include the map as part of the object of inquiry alongside the nutrition dataset and other CODAP features. The fourth phase carried lessons learned from this brief cycle of instruction into longer-term design efforts as the curriculum team designed subsequent units to more centrally highlight the map tool as part of data inquiry. We also present a missed opportunity to co-construct Third Spaces with students who translanguaged as they made sense of data. Responsiveness to organically emerging productive data investigation, as well as to linguistically marginalizing dimensions that were later observed, were central to subsequent unit design.

Theoretical Framework

This study explores the emergence of a Third Space wherein consequential data reasoning and curriculum design unfolded as a co-production of the teacher, students and researchers. Here, we briefly review theories related to Third Space and data reasoning to help ground these conceptualizations of learning and reasoning. The construct of a collective Third Space builds on an existing body of research and can be viewed as a particular kind of zone of proximal development. As an emergent and co-constructed environment, the Third Space is a particular social environment of development, in which students begin to reconceive who they are and what they might be able to accomplish academically and beyond. Learning in the Third Space has highlighted how its accomplishment is mediated by a range of tools and a reorganization in the hierarchies of classroom knowledge, as well as of the participation structures of more formal environments (Gutiérrez, 2008). In concert with the hybrid character of Third Space, consequential learning in the Third Space necessarily leverages both everyday (horizontal) and school-based (vertical) knowledge such that traditional notions of development generally defined along vertical dimensions (e.g., novice, competence) were challenged. Of significance, to this proposal, is that not only students, but the teacher and research team also began to jointly re-imagine and design for new curricular possibilities. As a social design-based experiment, this study's design also attuned to the co-participatory, iterative, and responsive potential of collaborative design and a shared practice (Gutiérrez & Jurow, 2016).

Our project seeks to support data reasoning as a way to understand both the world and oneself, and support Third Spaces in which new relationships between data, the world, and the self can emerge. Our conceptualization of data reasoning includes a number of practices central to data work, summarized by Rubin (2020) as: understanding the contexts in which observations are collected (and how valid/appropriate the data are for understanding a given system or situation); reasoning about mathematical features of the data including variability and aggregate patterns; flexibly visualizing data and understanding how they might be differently represented to reveal new trends and relationships; and drawing inferences from data back to the world. It also involves reasoning about one's personal relationships and situatedness relative to a given dataset and the systems it describes (Wilkerson & Polman, 2020), including locating or observing oneself within data; projecting self and community into aggregated social and historical data; and manipulating, critiquing, or generating datasets to better reflect one's own experiences. This case represents an instance in which we observed students engaging in many more personal, social, and representational explorations of data after a reorganization of activity co-designed by the students, teacher, and researchers.

Research Questions

While the goals of the WDS project were to support the emergence of Third Spaces within the *classroom* as students worked with data, this cycle of instruction also reflects the emergence of a Third Space that extended into teacher-researcher relations and subsequent curricular design for supporting data reasoning. The cycle of instruction we report here involved new paths of exploration by students, and illuminated productive ways to reorganize goals, tool use, and researcher-teacher roles to enrich the coconstruction of curriculum. Given the power and implications this holds for curricular co-design efforts, it is important to better understand its emergence and how it was sustained. This yielded the questions:

(1) How did the initial curricular goals in this cycle of instruction support the emergence of a Third Space in which relationships, roles and learning activities were reorganized to support students to use their everyday practices in data analysis?

(2) What does this cycle of instruction suggest about how productive reorganization of the classroom activity system can be sustained over time?

(3) How did this cycle of instruction inform future curricular design decisions and collaborative efforts?

Methodology

Our focal episode is drawn from a large corpus of data collected during our first, 21-day curricular enactment in multiple 7th grade class periods with a collaborating teacher we will refer to as Ms. Phillips. For each day of enactment, we captured audio-video recordings of whole-classroom interactions, audio and screen recordings of 2-3 focal groups of 2-3 students each per class, observer field notes, and audio-video recordings of mid-day debriefing sessions between researchers and the classroom teacher. We created activity logs, describing the general organization of activity for every 2 minute interval, from the whole-classroom and teacher debrief videos. We selected the events of Day 17 for deeper analyses after our codes helped us notice that multiple student groups demonstrated creative and unexpected data reasoning as they engaged with the data analysis tool on that day. After looking deeply at that student reasoning, we observed that it was grounded in how the teacher responded to an unexpected focus of students in the two periods she taught and observed earlier in the day. We chose to investigate this sequence of events more deeply as there seemed to be a significant reorganization of the intended classroom activity by the teacher and students.

Study Context

Our episode is drawn from Year 1 of the WDS project, during which we engaged in collaborative curricular design and enactment with science teachers at a school that served predominantly Latinx, emergent multilingual middle school learners in California's Bay Area in the U.S. The first unit we co-designed focused on analyzing nutrition data about breakfast foods. The collaborating teacher saw the unit as an opportunity to extend work the class had previously done exploring the nutritional causes of diabetes, a health issue she felt was prominent in the community. In this unit, students reflect on and collect data on their own breakfast practices and the practices of family and friends. They then compare their personal and community practices with how breakfasts are described in advertisements. After critically reflecting on foods and values in ads, they explore a nutritional dataset about cereals and consider how it might be changed to better reflect the foods and factors that they care about (rather than only what's 'normalized') when choosing breakfast. Finally, students analyze and transform the dataset, including by adding new records and variables, using the Common Online Data Analysis Platform ("CODAP"; Finzer & Damelin, 2016). Based on an analysis of a now modified dataset, they identify and justify their own "ideal and accessible breakfast."

While designed to be accessible to middle school students, CODAP involves specific data representations and features that are novel to students. With this in mind, before students worked in the digital environment, we introduced some of the data representations they would encounter and be able to do by having students work in small groups with paper versions of different cereal nutritional fact cards (labeled "case" cards in CODAP). Students explored and compared the small set of approximately 5 printed nutrition fact 'cards' for cereals, adding written nutrition fact cards for their own foods, and annotating both the cereal cards and their own foods to include information about other important variables (e.g. cost, taste, accessibility). Thus, students had some experience with the nutritional data and data representations before exploring them in the CODAP digital format on the Day 17 cycle of instruction described below.

Analysis

We re-emphasize here our interest in Third Space at the curricular design and enactment level, as the emergence of a collective ZoPED in which new forms of learning are made possible through a fundamental reorganization of activity such that students coproduce their learning. In this analysis we describe four distinct phases of activity in which we observed this sort of reorganization along the lines of a collective Third Space as it unfolded across the classroom enactment and related curricular co-design.

Phase 1: Designed Tool and Dataset Exploration Put the Map and Data at Odds

During the Day 17 cycle of instruction, students were first introduced in the digital environment to a nutritional dataset that included over 75 entries. The teacher and researchers had planned a day for students to openly explore the dataset and the CODAP environment. The goal was to help students develop confidence with the platform through centering students' interests and questions and elevating them as sensemakers. To do so, we included time for students to familiarize themselves with the larger nutrition dataset, and with useful features of CODAP including how to visualize and add new data and variables. The image to the left in Figure 1 provides an example of what we envisioned a student computer screen in CODAP would look like at the end of the exploration. The figure includes a nutritional "case card" for Maypo cereal and a graph of the sugar in all the cereals in the dataset. Given that geographical data was not a part of the dataset (note the blank map to the right of Figure 1), the teacher and researcher were surprised when a majority of students in the first two class periods reoriented from exploration with the nutrition data, and instead opened the blank map feature in CODAP to look for themselves. This move to position themselves in the map is consistent with research in data reasoning that students tend to first approach data in relationship to themselves (Kahn, 2020; Wilkerson & Laina, 2018).

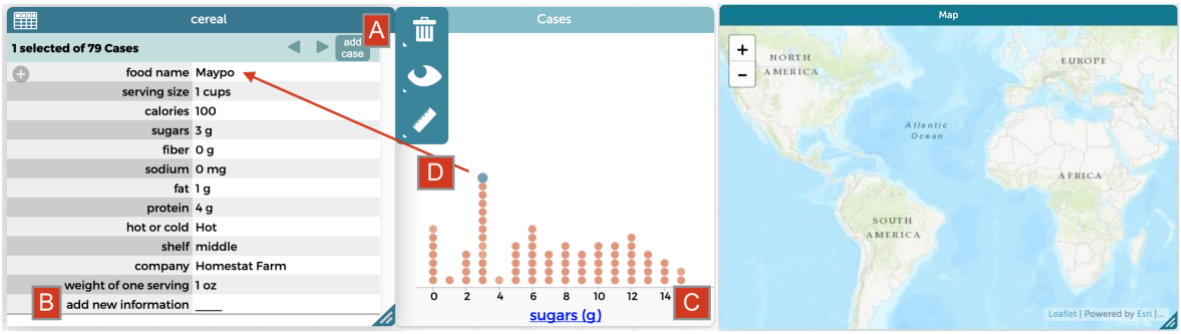

Figure 1. (left) CODAP environment with cereal dataset and anticipated features highlighted: add data (A), add variable (B), build graph (C), and selected data (D). (right) Map window in CODAP with no geographic data.

Phase 2: Teacher Responsiveness to Student Interest in the Map

After the first two class periods, during the mid-day debrief, the teacher and researcher discussed the unexpected and overwhelming student interest in the map. The researcher initially suggested redirecting students back to the cereal dataset and related CODAP functions, but the teacher wanted to support student interest. The teacher and researcher worked together to supplement an existing list of CODAP features on the whiteboard for students to explore (Figure 2, left side) with the prompts "any other helpful tool?" and "♥ How does the map represent your DATA STORY?" (Figure 2, right side). Her prompt on the board sanctioned use of the map and suggested that it could represent a "data story" that linked back to nutritional data.

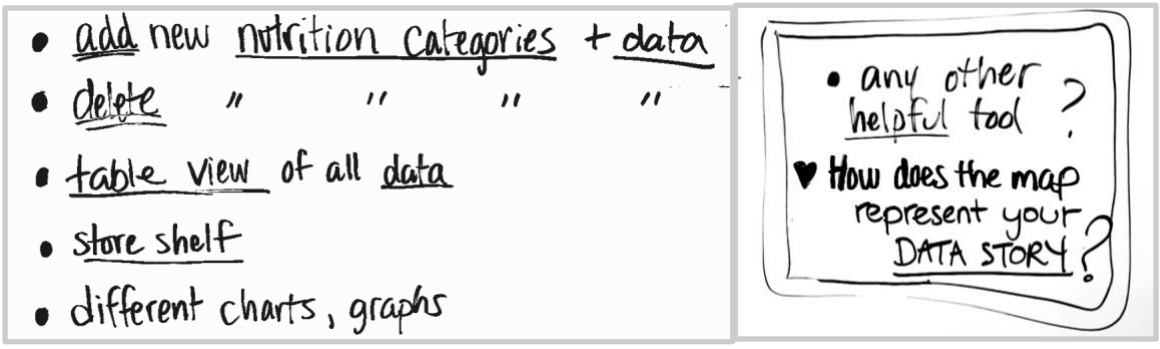

Figure 2. (left) Original CODAP exploration questions added at beginning of day. (right) Revised, map-focused exploration questions added to the board by Ms. Phillips after the mid-day debrief session.

During the debrief, Ms. Phillips' responsiveness as a teacher led her to reframe the task for class periods later that day. She felt that explicitly building on interest in the map would be generative for student learning. By leveraging student interest in the map, she encouraged deeper reasoning about data and students' use of evidence in scientific reasoning.

Phase 3: New Conceptualizations of the Dataset Relative to the Map

Following her decision to productively respond to student interest, in period 5, Ms. Phillips framed the map as a legitimate tool for exploration and investigation of data, health and nutrition. We observed unexpected consequential student data reasoning in two of our focal student groups. Initially they connected the nutrition focused dataset to the topic of diabetes and an organic interest in maps. Later they searched for evidence to support their claims that the map showed the location of people with diabetes. This path of inquiry, led to the development of a collective ZoPED wherein students co-constructed knowledge as they made a series of connections across prior investigations of diabetes and nutrition, personal interest in locating people on the map, and knowledge about how diabetes in lower income families may relate to the need to rely on inexpensive but sugar rich foods like cereal. Based on Ms. Phillips' reframing of the task in response to earlier interest in the map, several student groups began to reason about how nutrition related map might include geospatial information and patterns. Two of our focal groups proposed that the map could be a "diabetes map."

For example, one focal student pair in Period 5, upon exploring the map, speculated that it might provide a data visualization related to diabetes (which the class had studied earlier in the year). They spontaneously discovered the text box feature (Figure 3), and wrote reflections on important variables relevant to diabetes that were missing from the dataset. Ms. Phillips probed for specificity by asking what evidence they had to connect the map to diabetes rates. The pair wrote in the text box "I think the map could show where people with diabetes are around the world but we are looking for evidence." When they opened a graph window, it displayed a number of small dots scattered randomly. (This is a design feature, in which each dot represents an entry or "case" in the dataset which will be rearranged once the axes of the graph are defined by the user.) One student in this pair exclaimed upon seeing the scattered dots: "THESE probably are the people! The cases? [*mouse over scatterplot*] Like, the people?" Ms. Philips continued to encourage deeper exploration of how the data might be represented within different CODAP tools, asking "but are those dots on the map?" The pair looked for corresponding data points on the map, in the process reflecting aloud to each other about connections between geography, income, food access, and nutrition. They speculated that low income areas may be linked to higher cereal and sugar consumption, and thus higher diabetes rates. These ideas about a "diabetes map," which referenced units of study from earlier in the school year, connected geospatial information, reasoning about nutrition, and students' personal experiences in new, unexpected, and what we argue are profoundly productive ways. They also motivated these students to deeply consider what counts as a "case" and its "attributes" in the dataset, how data might be differently represented, and what the social context of the nutritional data might be; all fundamental components of data reasoning (Rubin, 2020).

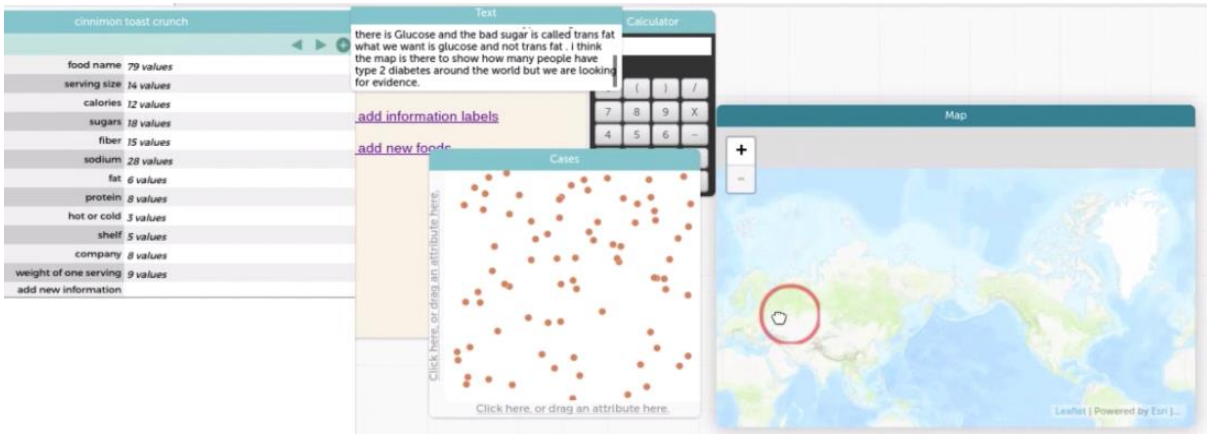

Figure 3. Screenshot featuring students' speculations about how nutrition related data might be visualized on a map. Their mouse click on the map is indicated with a red circle, and the text box reads "I think the map is there to show how many people have type 2 diabetes around the world but we are looking for evidence."

In working to reconcile the map with other features of the nutritional dataset and CODAP, this student pair deftly navigated a variety of tool features and potential data representations (case cards, scatterplots, and the map) as they worked to reconcile geography, broad views of nutrition, the more limited nutrition dataset, and their personal and social knowledge about how all of these might intersect. In the process, the pair also demonstrated several core elements of data reasoning: they worked to understand what counts as a *case* or observation in the dataset, especially as it might exist across multiple representations including geographic representations. In contrast to our intended explorations as highlighted in Figure 1, the investigation featured in Figure 3 is reorganized both in terms of how CODAP and its embedded tools are used (where a larger number and variety of tools are used), and in terms of the object of activity (which students expanded from a narrow comparison of nutrition facts about commercial cereals to instead consider how income affects consumers and how health is related to both geography and nutrition.

Another focal pair of students, similarly, began drawing connections between the nutrition dataset and broad themes of diabetes, geography, and visualization. As they opened and began to zoom and explore the map, one researcher approached the group to ask what they were doing. One student began, "We try to see how—" and the other continued "—like which state has the most diabetics in it." The researcher encouraged the pair to continue this line of exploration, asking, "what do you need to keep working on that?" They responded, "Say like, California's population is, like, 100 people? And like who has diabetes, and like Washington, 58? Something like that. We're not sure [if] that is what the map is used for." We interpret this to suggest that this pair, like the pair of students featured above, were expecting that the map could reflect proportions of people in different states who suffer from diabetes as an extension of the nutritional dataset.

Phase 4: Sustained Curricular Implications of Students' Map Focus

We find it meaningful that this rich engagement with the map emerged despite our plans, and deepened as a result of both student and teacher actions. Analyzed in the context of researcher, teacher and student dialogue, students' expansive data reasoning had been prompted by Ms. Phillips' reframing of the task in response to student interest in the map in earlier periods. Although our original goal for this day was to support a Third Space between teachers and students, we found it increasingly valuable to envision our broader attention to collaborative curricular design as a part of this emergent Third Space.

To attune to the lessons learned from Day 17, we have made geospatial data visualization a core part of how students engage with datasets and science topics. As part of this map dataset engagement, we support and leverage the practice of locating one's social worlds on maps that are related to or a part of, in different ways and at different scales, the datasets under study. For example, a grounding theme in a climate change unit is for students to think about their own "special places" in the world, and to interview friends and family about their "special places"—including how the landscape, everyday experience, and livability of these places may have been impacted by climate change and pollution. Students then locate these places on the map, creating a personally relevant but geographically distributed framework around which broader examinations of global climate and emissions patterns can be explored. Similarly, we make space for exploratory activities related to data and tools that can provide similar serendipitous moments for student interest to guide the teacher and researchers to more opportunities for learning.

There were also practices we observed in our data that were not leveraged or integrated by teachers and researchers in the moment. Notably, despite our stated commitment to supporting multilingual students, we observed that several students engaged in translanguaging during Day 17, especially as they jointly looked for themselves on the map and told stories about various places or origin or import. However, this practice went unsupported and remained marginalized at the time. Since this time we have significantly altered the way we support translanguaging in subsequent units, explicitly providing fully bilingual (Spanish and English) materials and models of flexible language use. However, our failure to notice and respond to this opportunity in the moment also reveals the degree to which our own and the teachers' research and instructional priorities shape what gets reorganized, and along what dimensions of activity, in the moment of curriculum enactment.

Discussion

We introduced this case as a new way to think of Third Space as a context for collaborative design. In particular, we offer this case as an entry point to think about new ways of thinking about what it means to design for equitable and consequential learning. Our findings reveal a few important considerations that are especially relevant to considering generative collaborative design in the context of formal, STEM-focused settings. First, we noted that shifts in the object of activity led to important rethinking of the use of CODAP as an exploratory tool, the nutrition dataset as the object of study, and of the goals of curriculum as both teachers and students, and the teacher and

researcher began to view their work as a shared practice—a practice marked by reciprocal relations of exchange. Second, we found that this example presents a new way of thinking about codesign not as receiving input or feedback either during the conceptualization or the design of an activity, but in the moment of enactment as new paths of exploration are revealed. This is particularly interesting within the context of a formal STEM classroom.

Finally, the case highlights how institutional, research, and teacher priorities can shape what sorts of reorganization is possible. Importantly, we observed the emergence of a Third Space and the reorganization of activity along the dimensions of tool use (the CODAP tool and its embedded maps, text boxes, graphs, and tables); the object of activity (from attending to patterns in data to also considering its connection to personal and social issues, including health topics previously studied in class); and social roles (as the teacher rejected researchers' recommendations in favor of following students' lead). At the same time, other student practices that were aligned with our purported goals and that co-occured with students' map use, such as translanguaging, were not taken up in the moment. This highlights the importance of communicating and revisiting project goals to elevate their priority. It also highlights the importance of reflecting on missing elements of reorganization to find "blind spots" and missed opportunities in design.

Future co-design efforts can learn from this case. Because students will initiate "counterscripts" and other "grammars of the Third Space" alongside and in tension with teacher-centered whole-class discourse (Gutiérrez, 2008), teachers should expect the emergence of such counterscripts and analyze them in real time to the best of our ability. As we saw in our project with student interest in the map, these counterscripts served as productive resources for learning that otherwise might have remained unnoticed and marginalized, but instead were productively leveraged for deeper learning in a collective ZoPED. If teachers and codesigners in other projects commit to actively searching for and uplifting student sensemaking to support a Third Space, they may also see a similarly productive reorganization of learning and see the emergence of another collective ZoPED.

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