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Data Theatre as an Entry Point to Data Literacy

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ABSTRACT: Data literacy is a growing area of focus across multiple disciplines in higher education. The dominant forms of introduction focus on computational toolchains and statistical ways of knowing. As data driven decision-making becomes more central to democratic processes, a larger group of learners must be engaged in order to ensure they have a seat at the table in civic settings. This requires a rethinking to support many paths into data literacy. In this paper we introduce “data theatre,” a set of activities designed for data novices that may have limited experience or comfort with spreadsheets, math, and other quantitative operations. Through iterative co-design over three workshops, we tested and produced two activity guides for educators, building on long-standing practices in participatory theatre that center social justice and liberation. Our initial findings provide very early evidence that this approach can help these learners overcome hesitations to working with information, begin building a critical perspective when viewing data, and create emotionally impactful data stories told through theatrical performance. This prototype work suggests to us that the concept of “Data theatre” warrants further study to build a more robust understanding of its affordances and limitations.

Keywords: Data literacy, Participatory theatre, Education, Social justice

1. Introduction

Data is shaping our lives and culture in a growing number of ways, from enabling our everyday digital activities, to supporting scientific breakthroughs, to guiding decision-making at local and international scales. Yet significant work has documented the negative impacts of this trend towards datafication (Datafication is a technological trend that seeks to capture large proportions of human activity and turn them into digital and quantitative data for processing (Couldry & Mejias 2019)), such as racialized outcomes in facial-detection based policing, embedded gender bias in automated hiring, racial disparities in algorithm-based healthcare diagnosis, and more (Eubanks, 2018; Noble, 2018; O’Neil, 2016). In response to these examples, broader conversations have begun to integrate questions of justice and equity in data-centered projects (D’Ignazio & Klein, 2020; Raffaghelli, 2020; Williams, 2020).

In parallel, data literacy has grown as a major topic in educational settings across technical and socio-political domains (Prado & Marzal, 2013; Klenke et al., 2020; Ryan et al., 2019; Timmermann & Havemann, 2020). We utilize a four-part definition for “data literacy,” engaging components related to acquiring data, processing and analyzing data, representing data, and storytelling with data for some purpose (Bhargava & D’Ignazio, 2015). Regions in Rwanda (UNICEF Rwanda, 2016) and Australia (“Data Literacy,” n.d.) have already introduced data literacy as part of their digital literacy curriculums, and the European Union has classified data literacy as an essential skill for the future and since 2016 has implemented policies and initiatives to support its development (Carretero et al., 2017). Typical introductions to data literacy at the university level follow patterns that have long existed, privileging those with math and technology fluency and thus reinforcing existing power asymmetries in data via their structure and application (Bourdieu & Passeron, 1990). These parallel trends expose a growing need for educational data literacy practices that center principles of justice, emancipation, and participation.

Motivated by this need, in this paper we build on historical theories of education and embodiment and participatory theatre to introduce our collaboratively designed “data theatre” workshop. The first workshop activity, entitled “Embody a Dataset,” invites participants to choreograph a representation of data using the other participants’ bodies. The second, entitled “Make a (Data) Scene,” asks teams of participants to find a story in a dataset and quickly design and perform a short scene to tell that story. We introduce motivations, summarize inspirations and related work, review the design process, document the activities, and discuss initial findings. This offers an initial case study of introducing data literacy centered around concepts of social justice and complements our larger body of work building arts-based invitations for data literacy learners.

1.1. The need for new paths into data literacy

Justice-informed pieces of building data literacy can look radically different than dominant current approaches. An important question to engage is precisely what “justice” means in our work. At a high level we embrace terms like “justice,” “equity,” and “capacity” to align with traditional struggles to retake power by those without. We take “social justice” to be a phrase defining a system where members of society can participate fully in their roles, achieve social mobility, and access collective support structures provided by their communities. We respect and engage the phrase’s long history in Western religious thinking, and its connections to more modern movements such as Liberation Theology (Gutierrez, 1988), but do not choose to center those roots in our application.

Taking approaches built on this definition is becoming critical as more decision-making in civic settings has become data-driven. Those who do not “speak” the language of data do not have social agency in this setting; we define that as an emerging problem for democratic society. How can those without a seat at the table in civic decision-making contexts that center data be authentically invited to participate? What barriers are holding them back? This work is targeted at developing alternate paths into this set of skills to create new ways for all people to learn to “speak data” so they can engage in society critically. We are informed by a conception of three main barriers: (1) focus on statistics (2) centering of technologies (3) control over impact.

First, we find that statistical analytic processes are the primary goal of many introductions to data. Browsing a mix of educational and professional training, one finds statistics and computation are most often front and center, introduced without significant discussion of context and ethics (Oliver & McNeil, 2021). This pattern follows a long arc of abstract mathematical thinking being centered in American educational curricular guidelines (Scheaffer & Jacobbe, 2014). The current manifestation of this history is the “STEM” approach to curricular priorities, proposed as a response to forecasted economic workforce needs (National Academies, 2007). There is a history of robust critique of the form and intent of US math education (Harouni, 2015). This has led to many learners forming identities as “math” or “non-math” people; definitions only somewhat related to their actual competence (Leonard et al., 2020; Cribbs et al., 2015). As data science was introduced and claimed by the field of statistics (Gould, 2017), quantitative analytical approaches became the standard at the expense of creating a more inclusive set of pathways into the field of working with data. Any introduction to data framed through a mathematics lens immediately raises a massive barrier to the group identifying as “non-math” people.

Second, introductions to data literacy in learning settings typically rely on a techno-centric understanding of these skills, focused on quantitative data stored and analyzed via computational means. Digitization has radically altered the costs of collecting, storing, and retrieving data of any type, placing computation centrally within any data project. Related Big Data skills have been in high demand for more than a decade (Manyika et al., 2011). Focusing on software that supports algorithmic operations on large datasets privileges those with access to computational tools, which differs across social, economic, and racial divides (Jackson et al., 2008). This privileges those with power and access. In addition, Small Data continues to play a large role in social contexts (Blair et al., 2014), despite the hype behind it’s “Big”-ger cousin (boyd & Crawford, 2012)

Third, datasets are too often separate from their potential applications and context of influence. Our prior work has critiqued data projects for their persistent lack of transparency and reliance on extractive collected data (D’Ignazio & Bhargava, 2015). The phrase “data is the new oil” is quite emblematic of the promise and peril of this approach (Flender, 2019). There is a relevant parallel here - just as with oil, the benefits of data projects are gleaned by those in power while the perils are experienced by those typically marginalized. This can be attributed, in part, to the fact that most data are extracted from a population or setting of study and taken to another context to be analyzed and interrogated. The analysis and impact conversations rarely integrate the subjects represented in the data, nor the communities that data-driven decisions will impact.

Prior work has begun to address this. Qualitative data can be introduced alongside quantitative to introduce non-computational analytical approaches (Henderson & Corry, 2020). Introductions can include concrete examples of alternate modes of data analysis such as collaborative meaning-making in urban planning processes (Boston Transportation Department, 2017), or story-finding and storytelling in the design of clothing and traditional fabrics (Katuli, 2019; Perovich et al., 2020). These examples show how discussion, aesthetics, design, and object construction (Willett et al., 2017) are forms of data analysis and storytelling. In addition, they demonstrate community ownership of data analysis, addressing our third main critique.

1.2. An arts-based data-theatre approach: Research questions

In this paper, we explore theatre, an arts-method, as a promising approach to address the broader need for new paths into speaking the language of data. Art-based methods have long been used to enhance learning in diverse disciplines, such as medicine (de la Croix et al., 2011), math (Hally & Sinha, 2018), and physics (Solomon et al., 2021). These methods offer learners an opportunity to tap into their kinesthetic intelligence by using their body to express or understand ideas, concepts, and experiences (Lowenfield, 1957). This may appeal to learners that embraced performance-based media for sharing information, including data-based facts (such as Tiktok and Instagram).

We describe the iterative design process, and initial findings, from a series of “data theatre” workshops we led online and in person. Our design process finds ample overlaps between the world of participatory theatre, which has a traditional focus on social justice, and our arts-based approaches to data literacy. The intersection between data literacy, justice, and the barriers enumerated above, leads us to our driving motivation: exploring how participatory theatre can help us build novel introductions to data that center on justice. Specifically, we formulated three central research questions:

- RQ1 - Literacy: In what ways can theatrical activities introduce learners to data literacy skills?
- RQ2 - Critique: How might embodying data help lead to a critical questioning of datasets and their use?
- RQ3 - Impact: Does the process of performing a data story change performer or audience perspectives on the subjects of the data?

We engage these questions in our workshop design and throughout this paper. At the same time, this early-stage work is still speculative and exploratory as we work with learners to build a practice of data theatre, developing a novel approach as a basis for further study. Future work will explore ways to more robustly assess causal relationships between workshops and data literacy outcomes, relative to more traditional data learning activities.

2. Related work

In broaching the questions of what “data theatre” might look like, what justice-oriented learning goals it might fulfill, and its potential for impact, we build on significant work in three areas: (1) education and embodiment, (2) participatory theatre practices (3) professional theatre practice.

This is guided by central design principles established in our previous work (Bhargava & D’Ignazio, 2015):

- Participation from all parties
- Learner-guided explorations
- Facilitation over teaching
- Accessibility to a diverse set of learners
- Focus on real problems in the community

In prior projects these principles have guided the development of learning experiences to design and paint community data murals (Bhargava et al., 2016) and build physical data sculptures with crafts materials (Bhargava & D’Ignazio, 2017). This new foray into activities for data theatre introduces our work to a rich history of education through embodiment, and introduces a new performative output for the learning activities we create.

2.1. Education and embodiment

Research in education and embodiment surfaces the importance of emancipation through critical data literacies and points to the ways in which physical movement and action may alter understanding, perception, and memory.

Many pedagogical approaches have embraced justice and equity at their core. We take strong inspiration from Dewey’s foundational connection between education and democracy (Dewey, 1903) and Freire’s approach to emancipatory education (Freire, 1968). In the context of data literacy, we specifically posit that the application of this idea to modern day involves both understanding the oppression of data processes integrated into civic governance and taking back power to use data in service of collective justice (Couldry & Mejias 2019). Functionally, this builds on research into how learning can be more effective when the subject is interrogating issues that matter in their communities (Zeidler et al., 2005). From this work we draw an approach that works

with local community data, provides creative freedom to find narratives in it, and focuses on potential real-world impact of the process.

An emerging definition of “critical data literacy” applies Freire’s approach to the concept of data literacy (Tygel & Kirsch, 2015; Sander, 2020). This conceptualization offers links to previous movements in critical media literacy and digital literacy (Knaus, 2020). It also provides a theoretical framework to underpin the design of activities and interventions for educational contexts that seek to raise awareness of the datafied society around us and put data in the hands of the communities it is too often extracted from. Critical data literacy embeds a hope for empowerment through activism and social change (Gutiérrez, 2018). The approach of critical data literacy offers us theoretical framing within which to situate our activities, and a set of related projects that our work connects to.

Finally, we find inspiration in embodied approaches to learning. These build on understandings of learning as situated in social context, activity, norms, experience, and physicality (Lakoff & Johnson, 1999). Indeed, scholars have acknowledged the power of embodied experiences to shape learning (Höök, 2018) and promote empathy (Yap, 2016). Going further, we embrace the idea that all forms of knowing are rooted in the “somatic phenomenon” of the learner - the physical experiences they undergo and create while in learning settings (Abrahamson & Lindgren, 2014; Malinverni & Pares, 2014). Data science educators have built on this type of definition to offer activities such as bodily data sorting and physical infographics (Sommer & Polman, 2017). The latter two are examples of participatory simulations - opportunities to socially construct an understanding of phenomenon by embodying it. In this practice the act of “knowing” itself is participatory and shapes outcomes (Barab et al., 1999). The emerging concept of “data feminism” embraces this, suggesting data embodiment and data “visceralization” be valued as ways of knowing data (D’Ignazio & Klein, 2020).

Furthermore, our definition of justice comes together with a motivation in an attempt to embrace “epistemological pluralism” in the domain of data science. As defined by Turkle and Papert, epistemological pluralism is an “acceptance of multiple ways of knowing and thinking,” with each “equally valid on its own terms” (Turkle & Papert, 2015). Their conceptualization connects to gender rights in learning settings, respect for previously dismissed concretized learning, and notions of body syntonicity. We are inspired and motivated to create a data science that engages and values epistemological pluralism, moving beyond a belief that algorithmic and formal thinking is naturally superior. Embodied approaches to building data literacy are one piece of this puzzle.

2.2. Participatory theatre

Our work draws on the long-standing focus on liberation in participatory theatre and the many practical activities built by expert practitioners in this space over decades of contextual work with communities.

The approach of “epic theatre” is a common root for many of these practices, built around the idea that theatrical practices can provoke the audience to reflect on the world as it is, rather than suspending disbelief and entering an imagined world via the performance (Styan, 1981). Theatre of the Oppressed, a form of theatre designed for social and political activism, explores oppression in all forms - internal / external, individual / societal, and more (Boal, 1993). Verbatim theatre (Catchesides, 2020), and image theatre (Farmer, 2014) are all examples of other approaches that have grown from this common theoretical core and been successfully used for empowerment in communities. Playback theatre, where participants share experiences which are then “played back” to the broader group through, has been used to promote compassion and understanding in medical education (Salas et al., 2013), healing and reconciliation for post-war communities (Dirnstorfer & Saud, 2020), mental-health recovery (Moran & Alon, 2011), and healing for adolescents in refugee camps (Edelbi, 2020). It aims to create a deeper, multi-dimensional understanding of experiences — building empowerment and engagement in decision-making.

These approaches interrupt the theatrical experience and charge participants with decision making, analysis, and sharing judgment, blurring the lines between actors and spectators. The audience may have strong visceral and emotional reactions to a piece, but they are more likely to take social action when they are invited to act in the experience of the theatre. Functionally, these approaches work in support of critical thinking and participatory engagement via what Brecht refers to as a “dialectical” approach, focused on meaning making through engagement of potentially opposing perspectives (Mumford, 2008).

These forms of theatre align with our goal to create participatory spaces that bring people together to learn how to speak and embody data, and leverage this knowledge towards goals within their communities. The element of shared discovery and storytelling, structurally influenced by the perspectives and experiences of participants, can

create a sense of control and responsibility amongst the collaborators (PARCOS, 2020). In the words of social science dramatists and researchers Ross Gray and Christina Sindig, “A drama that emerges from such a process is very much a negotiated settlement, a collective achievement” (Gray & Sindig, 2002). Participant audiences reconcile with their experiences through story building, a process that connects strongly to the definition of critical data literacy.

2.3. Professional performances

Finally, we looked to professional theatre practice for inspirations of performative data productions in action. The 2015 piece *A Sort of Joy (Thousands of Exhausted Things)*, created by the theatre troupe Elevator Repair Service and the data visualization group Office of Creative Research (Thorp, 2015) uses metadata from the New York City Museum of Modern Art’s collection to create a performance that highlights the gender of artists whose pieces are in the collection. Performed at the MoMA itself, the piece centers around faux visitors reading out names in cadence. A circle of men stands with three women apart. The men speak other male names for several minutes, until finally the women speak for the first time - saying “Mary” to highlight the gender gap in museum acquisitions. The entire structure of the piece pulls the audience into the act of questioning the gender diversity of the MoMA’s collection though experiencing the gaps in the representation via their eyes, ears, and body as it awaits the next time the women speak.

To further explore and understand professional practice, we conducted two interviews with professionals in the field of theatre. Our first interview was with Christopher Ellinger, Founder and Director of True Story Theater, a nonprofit playback theatre company that offers improvisational performances and workshops to community groups, businesses, and individuals. Ellinger shared a wealth of experiences around how to help participants develop self-awareness and promote empowerment, reconciliation, and decision-making. Our second interview was with Frederica Fragapane, an award-winning Italian information designer, who researches the mutualistic relationship between data visualization and performance. Some of her work has integrated traditional practices with projected data visualizations that reflect what is happening in the play - such as network diagrams of character interactions projected behind an unfolding scene (Fragapane, 2017). Her work treats theatrical production as an artifact for interpretation and representation via standard data visualization approaches; an alternate conception of what data theatre could be.

3. Workshop and activity design

With this theoretical grounding, and related work across disciplines, we used an iterative process to develop a set of data theatre activities centered on justice. Over three workshops we iterated on the design of the activities with students and qualitatively assessed the experiences against our research questions and motivations. Each workshop focused on one of our driving research questions, while touching on all of them. Our workshops are also informed by interviews with two professionals in the field of participatory theatre. In this section we summarize our methods, workshops, and observations.

3.1. Workshop structure and development

The three workshops included (1) an initial exploratory workshop focused on RQ1- Literacy, (2) a prototype theatre-focused workshop focused on RQ2 - Critique, and (3) a single session in-class workshop focused on RQ3 - Impact (Table 1).

Table 1. Workshop format and details

Workshop #1	Workshop #2	Workshop #3
Exploring Movement	Prototype Data Theatre	In-Class Data Theatre
May 2019	December 2020	February 2021
In-person	Virtual (via Zoom)	In-person
Graduate students	Theatre undergraduates	Theatre undergraduates
15 participants	10 participants	12 participants
Self-selected	Self-selected	Class members
Focused on RQ1 - Literacy	Focused on RQ1 - Critique	Focused on RQ3 - Impact

Each workshop was built around an introductory experience to set tone and activate participants’ bodies, followed by two in-depth activities. Workshops were 1.5 hours, with interspersed reflection discussions between

activities. Discussions with participants during the sessions were facilitated as semi-structured focus groups, consisting of thematic prompts from the facilitator followed by open time for reaction and engagement.

At each workshop we utilized the same data handouts. These included

- A 1-page handout with two charts about ice cream consumption in the US: a line chart of per-capita consumption by year, and results of a small survey about favorite flavors.
- A 4-page handout about issues of food security in a local community, based on surveys administered by a non-profit. This included items such as tables summarizing time spent getting groceries, quotes about barriers to acquiring appropriate food, and bar charts of population demographics.
- A 4-page handout about healthy eating habits from a government-run local early childhood support program. This included tables of population demographics, bar charts indicating family size and country of origin, quotes about preferred patterns of eating, and more.

Between sessions we iterated on the activities and incorporated virtual or physical constraints in addition to participant feedback. In Workshops #1 and #2 we attempted to engage participants as co-designers of the experience; commenting on, and suggesting ideas for, how to run activities in this domain. This deliberately reinforced our approach to justice and empowerment, not just in terms of product but also the processes we undertook. Due to the speculative nature of this work, and our desire to have participant feedback shape next steps, we hoped this format would allow space for topics and reflections we did not anticipate to emerge.

3.2. Data collection and analysis

Multiple streams of data were collected at each workshop. Each workshop was video recorded and automatically transcribed to support later evaluation work. During the workshops, members of the research team took on one of three roles:

- Facilitator: the leader responsible for introducing activities, monitoring progress during breakout sessions, and prompting reflection.
- Non-participant observer: a “fly on the wall” tasked with taking notes about the interactions and reactions of participants during the session itself, including notable participant statements and reflections.
- Participant: worked alongside students and contributed comments on the social dynamics of the session after the fact.

We held a short debrief after each workshop to share comments and reflections, with collective note-taking happening in a shared online document.

We conducted evaluation through qualitative review of these outputs. One team member reviewed the video transcription, observer notes, and debrief notes to synthesize high level findings. This involved looking for recurring observations based on connections to our three research questions and extracting key quotes from participants that were marked or mentioned by researchers in any of the notes taken. We took a hybrid approach to doing this qualitative descriptive coding, based on both our primary research questions and topics that emerged within the transcriptions and notes themselves. We deemed this appropriate because while we do have some key research questions, this work was also highly exploratory in nature. Findings from this qualitative data analysis were brought to the larger research team for reflection and further discussion.

3.3. Workshop #1: Exploring movement and data literacy

Our first workshop was an exploration of movement and data designed to surface initial reactions and reflections (Table 1). The driving research question for this workshop was RQ1 - Literacy. We structured it to evaluate what kind of basic data literacy skills could be explored via movement and embodiment.

3.3.1. Activities

The two central activities were (1) a “puppeting” experience and (2) a collaborative design of a short performance in small teams.

Activity #1 – Puppeting: This activity was inspired by image theatre (see Section 2.2), where participants “sculpt” bodies to embody perspectives, and augmented by movement cards (Figure 1) we developed through a

preliminary review of movement research. In this activity, each group of four received a movement card (Figure 1) and a dataset (Figure 2). Each pair was invited to review the data handout, about ice cream consumption in the US (Figure 3), and then to instruct the other pair on positioning their bodies to express the data, constraining their actions to the movement prompt card they received. Then the roles switched.

Figure 1. A sample of the movement cards provided to participants

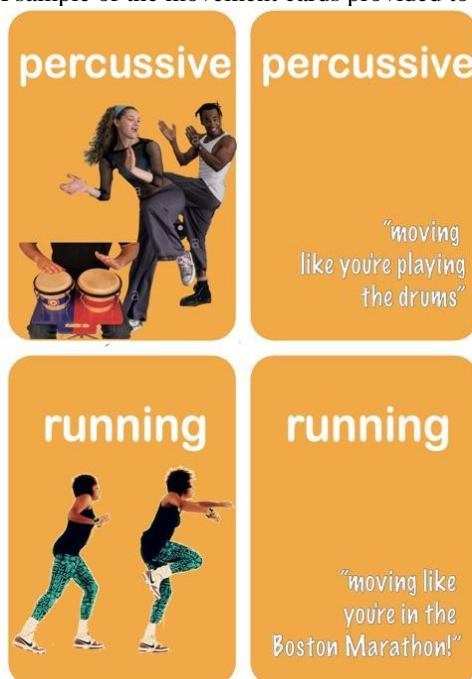
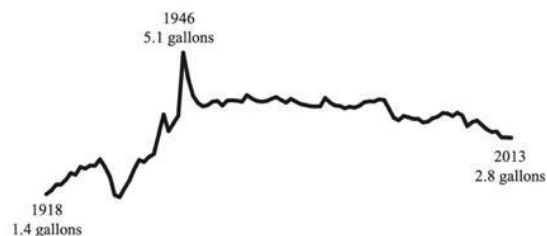


Figure 2. The ice-cream data handout

Ice Cream In the US

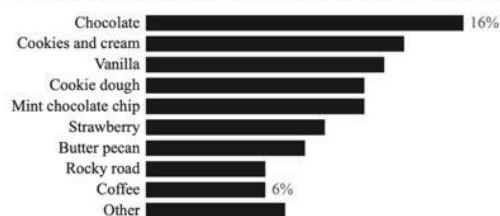
How Much Do We Eat?

This chart shows the gallons of ice cream an average person would eat in a year.



Our Favorite Flavors

This survey asked 1000 people what their favorite flavor of ice cream was in 2014



Sources: USDA, Vision Critical

Activity #2 – Collaborative design of a short performance: Each group received one of two multi-page qualitative and quantitative data handouts; one focused on local food security data, the other on a local program around healthy eating. The groups were instructed to review and discuss the data handout and develop a series of movements to represent a story that they saw within it. After about 15 minutes of work time, the groups were re-engaged to share their performances (if they wished to).

Figure 3. Participants reviewing data and planning their performance



3.3.2. Observations and reflections

Some of the pieces created included:

- Puppeting bodies to mimic the curve of a line chart showing ice cream consumption over time.
- Puppeting peers to mime ice cream being scooped and served based on select rates of consumption.
- A performance representing hunger via painful expressions and doubling over, and highlighting barriers to food access by performing the wait at a bus stop.

The overall workshop was both playful and reflective. We were successfully able to create an atmosphere of just trying things out; as seen in comments about “we were having fun,” “that was really fun,” and “all that data stuff was a lot of fun.” The last one is particularly telling for us, because it suggests that the participant did not expect working with data to be fun.

Specifically related to RQ1 - Literacy, we saw initial evidence that participants were engaging with some core areas of data literacy: encodings, representation, and editorial choices in storytelling.

The two puppeting examples shared above indicate that participants were exploring a variety of modes for representing data in physical form. The first group commented that they were recreating the chart “through bodily movements like a one-to-one translation.” This suggests to us that this team was exploring how to bring the existing 2D representation into a 3D space with their bodies. Perhaps their meaning-making through mimicking the chart might be like learning to read a graph? On the other hand, the second example, miming ice cream, to us was akin to using symbols to represent data, as in pictographs. They were using the literal act captured in the data, eating ice cream, to represent to the audience a story they saw in the data. This reflects evidence from other work where we found early novice data literacy learners often draw symbolic depictions to represent data (Bhargava et al., 2021). Taken together, these two examples show participants engaged in explorations of body-based representation that brings them into contact with questions asked in more traditional data literacy introductions. They stated how the intention to “to use the movements to explain the data,” and “used different movements for different quantities.” The visual encoding space of traditional charts is well-documented and explored, but the encoding and representations possible via embodiment merit further investigation.

We were also provoked into questions about predisposed notions of “analysis” and “embodiment” being separate tasks. One participant noted “it’s really weird to think about how to turn numbers into something... having no scales changes things.” This offers a potentially interesting hypothesis that relates to prior work reviewed on education and embodiment (Lakoff & Johnson, 1999; Höök, 2018; D’Ignazio & Klein, 2020), specifically that non-graph-like embodied ways of understanding were being dismissed by participants even when prompted to create embodied representations of knowledge. Interestingly, one participant went further and pointed out that the limits of embodiment also mattered - “what are we trying to do... what can we not do physically?” Relatedly, another commented that it “was really interesting to think about how you make scales different based on the type

of visualization”; perhaps demonstrating an ability to reflect on chart design decisions after the physical act of embodying the data.

The performance activity showed participants wrestling with questions of turning a data into a story. One noted that “it is really hard to represent all of the data,” a reflection related to questions of what data is included in a story. When prompted, one participant more directly commented that “I found the hardest part was to create a bit of a narrative there... how do we take the different parts of the data and make a story out of it.” One participant in response commented that “even with the same graph, we interpret” - perhaps pointing to an early understanding that any data can contain a multitude of stories. Another pointed out that as an audience member you “don’t have a context for the data... you’re almost looking more closely, trying to process every movement.” Storytelling with data is a difficult skill, but these comments suggest that the performance activity in particular was leading participants to wrestle with it. This provides early evidence that our two activities were helping participants explore some fundamental pieces of data literacy - specifically how to represent data and turn it into a story.

On a final note, we found most people focused on acting out stories from the data as skits, while a few translated the data into more abstract dance-like movement. Their skits were very narrative in their structure, while the dance seemed to be evoking emotions they saw in the data. This drove a shift in our project structure, offering two paths: (1) diving into data and dance (publication forthcoming), and (2) exploring data and theatre (described in this paper).

3.4. Workshop #2: Prototype data theatre

We specifically designed the next workshop to use practices of participatory, socially engaged theatre to build data literacy in a group of participants that did not see themselves as “speaking data.” We built on a Brechtian approach to theatrical practice and invited participants in as co-designers of the activities; after each activity we asked them to take off their “participant hat” and comment on the design of the activity itself with their “facilitator/educator hat.” Building on what we observed at the first exploratory workshop, and our learnings from the field of participatory theatre, our driving research question for this workshop was RQ2 - Critique.

3.4.1. Activities

The two central activities were (1) a collective “puppeting” experience and (2) creating short data skits in small groups.

Activity #1 – Collective Puppeting: Here we extended the puppeting activity to the group at large - pairs of participants designed ways to showcase something they saw in the ice-cream data by instructing the rest of us about what to do with our bodies. This connected to our goal of breaking down the divide between audience and performers - inviting the entire audience to make meaning by performing a piece. The reflection discussion afterward focused on questions more targeted at critical thinking.

Activity #2 – Data Skits: After discussing what makes up a “story” (versus just raw data) we introduced the idea of finding a story and designing a 2–3-minute skit that tells that story. To dig into RQ3 - Impact a bit more we asked them to focus on conveying one key emotion to their audience. They were given about 15 minutes for this activity and invited to perform their piece after that.

3.4.2. Observations and reflections

Some of the pieces created included:

- Puppeting the group to compose a line chart with their arms across a grid of video boxes in Zoom.
- Puppeting one participant at a time to represent the popularity of a flavor of ice cream by trying to represent it via movement and sound.
- A skit comparing time spent getting to a grocery store by different populations via pretending to drive a car.
- A skit acting out a debate between two fictional community members about whether the data about cultural eating norms was reductive, stereotypical and offensive.

Overall, we were pleasantly surprised at the engagement from participants despite the constraints of the virtual setting. We hypothesize that leading silly introductory activities within the boxes on Zoom created a sense of failure and awkwardness being a normal part of the process, freeing participants to be slightly more uninhibited in their ideas. While reflecting on this first activity, some participants shared that they were a little lost at first, another commented that “once we got into it, it was really really fun.” Again, this reinforced a finding from Workshop #1, specifically that embodying data via our activities was a fun process.

The car driving skit provided an evocative example of using theatrics to create space for questioning in the audience (similar to the *A Sort of Joy* piece described in 2.3). The awkward silence of the final driver continuing to drive for far too long created space to question why their drive was so much longer.

A number of comments offered early evidence that we are creating a new pathway for learners who perceive themselves as “non-numbers” people. An incidental conversation as the workshop was starting led to many participants self-identifying as “non-numbers people.” This binary identity formation in relation to math creates a real barrier to entering domains that learners assess as numbers-heavy (Leonard et al., 2020). In future workshops we would more robustly capture this in a pre-survey, providing an informal qualitative indication of how the group felt. In addition, we could embrace Leonard’s notion of “naming discomfort” as a potential intentional response to try break down any perceived barriers felt by participants.

The debate skit mentioned above provided our strongest example of participants engaging in critical questioning of datasets and their use (as described in RQ2 – Critique). They challenged the assumptions they saw in the data. Based on our decade of experience running data literacy activities we found this quote notable - critiquing the data like this rarely happens with novices. The fact that this group did just that suggests that we were able to create an environment where they felt comfortable engaging their critical thinking skills despite the power dynamics at play within the workshop. In addition, some of this early evidence related to our commentary on control of impact (section 1.1). Our choice to use local data resonated with a number of the participants. One noted that our approach “allows communities to redefine what is a hard-tangible fact with emotions” and lets “the audience have freedom to take from it what they are going to take from it.” These examples suggest that our Freire-inspired approach to designing with community data with impact might have successfully introduced the basics of the critical data literacy concept introduced previously.

At the process level, one helpful comment suggested that calling them data “skits” was inappropriate; the term implies humor, and this was not engaging in humorous approaches.

3.5. Workshop #3: In-class data theatre

Our third workshop was a single session in one of the author’s in-person Movement course for undergraduate theatre majors. As with workshop #2, our main goals revolved around testing the activities to determine how they support helping a new group of participants start to move from data to story through the design of participatory performances.

3.5.1. Activities

The two central activities were (1) a prompt to “embody a dataset” and (2) a prompt to “make a (data) scene.”

Activity #1 – Embody a Dataset: We did not substantially alter this activity.

Activity #2 – Make a (Data) Scene: Building on our learning from Ellinger of True Story Theatre (see 2.3), we added a bit more intentionality in how we introduced the data. Using the same handouts, we took more time to address the fact that they might connect to negative experiences of people in the room and we attempted to create space to honor and digest that. Additionally, we began using the term “scene” in place of “skit.”

3.5.2. Observations and reflections

Some of the pieces created included:

- Embodying data about ice cream consumption over time by directing the class to move around the space and hum, while varying volume and speed based on the data instructions.
- Embodying data about consumption levels via standing at different heights.

- A scene making physical all the obstacles that a disadvantaged person faces in accessing food for her family, from time, to distance, to money, in a journey to feed her children.
- A dramatic scene where a character was taunted with healthy food and other resources that were too high above her head or too fast for her to catch.

The “embody” activity offered two interesting notes. The first related to sound and movement - this was the first intentional use of encoding via sound that we saw. We found it encouraging that these activities led participants to a mode of data representation that has only recently gained in popularity - sonification (Lenzi & Ciuccarelli, 2020). The second relates to “binning” - the process in statistics of grouping a set of discrete data into larger categories. In this specific case, the team quickly averaged ice cream consumption levels by decade to instruct participants how to stand. In more traditional data literacy programs, we often see learners introduced to the idea of binning and how it can alter the results of an analysis (based on bin size). Here we saw the participants come to the idea themselves and used the opportunity to discuss the idea and concerns during the reflection after they presented it. These both suggest interesting learnings related to the analysis and representation pieces of data literacy.

Regarding RQ3 - Impact, we saw early indications of participants reflecting on the subjects of the data in meaningful ways. One group noted that the “make a scene” activity helped them get around the dehumanization that can occur in traditional representations, saying specifically that “numbers / statistics are not just numbers, they represent people going through this.” A viewer of that scene said it “pulled me in because it matched something that happened to me in my life.” These comments help us dig into some of the driving questions related to how performing a dataset could change perspectives on those represented by the data, and potentially build empathy for their situation. Furthermore, one participant started to get at a potentially causal link that merits more investigation, stating that their “emotional response to the data was a lot stronger when we embodied the data.” However, another commented that one weakness is how “the paper visual representation is stronger because you can reflect back and look at it ... it is locked in time.” These suggest the participants were engaged in the act of embodying the data and were reflecting on its affordances; there may be aspects such as recall that are not supported through embodied representation.

3.6. Synthesizing two activities

Based on our interaction and reflections from the 3 separate workshops we synthesized our learnings into two data theatre learning activities for novice audiences. We offer these as the foundation of an approach to data theatre in service of equity and engagement in learning settings that focus on justice. The “Embody a Dataset” and “Make a (Data) Scene” activities are documented in activity guides for educators attached as supplemental material to this paper.

4. Synthesis and discussion

In this section we highlight findings and reflections across workshops and research questions. In particular, we synthesize and discuss our initial findings in relation to each of our guiding research questions. With our focus on undergraduate theatre students as primary participants, findings may not be generalizable to other audiences we plan to work with, such as community organizations. However, the findings do suggest an initial foundation on which to build and are applicable for others wishing to work with this same or related audiences. Our early observations suggest that data theatre is a novel entry point into data literacy, worthy of more study (as detailed in 5 below).

4.1. Creating many paths for many learners (RQ1 - Literacy)

Our initial workshops and prototype activities suggest that data theatre can introduce participants to several core data literacy skills - reading data, picking representations, and creating stories.

Our activities were appealing to audiences that might not be drawn to spreadsheets, math, and the computational analytic tools typically used in introductory data literacy sessions. Participants associated the term “data” with other words such as “information,” “numbers,” “research,” “charts,” and “technology.” When prompted to represent “data” with a sound of movement, we heard computational bleeps, bloops, and mechanized motions. In addition, we found in Workshops #2 and #3 that our participants did not identify as “math people” (Leonard et

al., 2020). One participant noted, “You are translating your math mind into a creative mind, into a story mind, into a people mind.” Another participant echoed that “(we were) looking at a piece of data and the numbers and quantitative stuff, but what’s the story here.” A third said that “I think that is part of finding the stories, you have to translate.” These comments suggest that participants were building basic data literacy skills, specifically in the realms of representation and storytelling. Our responses could employ Cribbs’ proposed pathway from “performance” to “recognition” to “mathematics identify” more intentionally in response to these types of comments about engaging different parts of one’s brain (Cribbs et al., 2015). Combined, these observations deepen our motivation to create pathways into data literacy for learners who are not attracted to the existing computation-centered introductions, specifically related to our concern about citizens’ abilities to join in civic discussions that are increasingly data-centered.

This returns to our goal of validating multiple ways of knowing in the field of data science. Specifically informed by the concept of epistemological pluralism (Turkle & Papert, 2015) and data feminism (D’Ignazio & Klein, 2020), data theatre can serve as an entry point for learners that take a different approach to thinking through data. For instance, while many introductions to data begin with aggregating a spreadsheet, we saw many of our participants begin by trying to understand one data point. Perhaps like the story of Anne that Turkle and Papert’s share, where the “bricoleur programmer” covers her bird like a painter might, data science needs to embrace solutions that are informed by approaches from other domains, even if they seem “sub-optimal” or “inefficient” to experts. Our “data point explorer” should also be welcomed as having a valid way of exploring a dataset. Another connection here is to the idea of kinesthetic memory as another way of knowing (Lowenfield, 1957). Participants in our workshops were using their body to process, understand, and express data concepts and interpretations.

4.2. Building critical data literacy (RQ2 - Critique)

In this context, we see data theatre as a promising approach that could help engage a critical frame of mind about the data itself, though this work did not engage critique of data’s use directly.

It is illuminating to bring this discussion back to Tygel and Kirsch’s (2015) conceptualization of critical data literacy. Our participants pointed out that “statistics and data sometimes generalize experiences and are not telling the whole story just by looking at the numbers,” and “using reflection and performance shows the story underneath it that the data attempts to bury.” These comments suggest that, as Tygel and Kirsch (2015) define it, our participants are seeing data as an “output of a social process.” In our second workshop, one participant noted that “I was really self-conscious about being critical of the data set,” but then they proceeded to despite that hesitation (creating the data debate described in section 3.4.2). In reference to Tygel and Kirsch’s (2015) definition again, we argue this group demonstrated data “manipulated based on explicit objectives” and including a “social evaluation of what message should be transmitted.” Specifically, we found participants were willing to interrogate and question data when asked to physically embody it. As one participant noted in the Workshop #3, you “bring your own interpretation or experience to the performance.” A data feminist might suggest you do the same with data - “consider context” is the sixth principle of data feminism (D’Ignazio & Klein, 2020).

We saw less evidence that we effectively prompted critical reflection about the use of data in social settings as disempowering or emancipatory. This has become more important to engage as large companies with massive technical capacity continue to use data-based systems to impact far larger swaths of the population, with more significant impacts on the historically marginalized (Noble, 2018). If we create new paths to engage populations in civic data-driven decision making, our definition of justice indicates it must be in service of those with the most potential to be harmed by the decision. Our prompts were not designed to help participants consider the impacts of data use in a community.

4.3. Creating impactful embodied experiences (RQ3 - Impact)

These initial workshops lead us to believe that our “Make a (Data) Scene” activity can rehumanize data and potentially build empathy and engagement for participants, but we are left with more questions about impacts for the audience.

One consistent reflection in our work was that the theatrical embodiments of these data points help participants rehumanize the data. Typical introductions to data are decontextualized from the subjects of the data, and their points of impact (Oliver & McNeil, 2021), a critique we have made in other work about introductions to data literacy (D’Ignazio & Bhargava, 2015). We argue that with a justice-focused lens it is centrally important to

integrate the lived experience of those represented within a dataset, and the context of its potential implications. Participants reflected that the scene activity “grounded it in the actual people” and “got me thinking about the people behind the data, behind the numbers.” They were “telling the story of the people behind the data.” This provides early evidence that embodying data may have helped these learners remember that data often represents people and experiences. This work allows them to consider their own experiences and knowledge in relation to the communities the data is about — key steps for building empathy.

Furthermore, we heard some reflections suggesting that our activities created impactful reflective experiences for the participants themselves. For instance, responding to a question about the datasets, one participant noted that it “pulled me in because it matched something that happened to me in my life.” This comment reinforces findings from the field of teaching “data for good,” where educators have found that learners get drawn in by working on datasets about problems they have experienced or are interested in (Bhargava, in press). This also relates to comments from our interview with Ellinger of True Story Theatre, about creating space to process seeing oneself in the data — engaging the audience in empathetic reasoning.

5. Conclusions and next steps

In this paper we discuss the motivations, inspirations, process, and findings from the creation of a set of “data theatre” activities in a higher education setting. We offer the activities as an alternate entryway to building a critical data literacy, one that builds on processes rooted in questions of justice and equity, decentering technology and inviting sets of learners who are not engaged through current approaches. We find early evidence that the data theatre approach is effective at helping participants build some data literacy skills without introductions to statistics and computational tools, reflect critically on datasets and their intended use, and engage in emotionally meaningful embodied performance of data stories.

In a datafied world, we argue that democratic societies are morally responsible to govern through understandable mechanisms. Data theatre offers one path to making data more understandable, particularly for learners without access to technology, or who do not take to spreadsheets. We hope the activity guides included as appendices contribute concretely to other educators’ toolboxes. Theatre based introductions to data literacy can be an effective entry point into data literacy that complements other approaches and potentially lowers barriers to certain content based on their embodied nature.

5.1. Next steps

In an educational setting and a community setting, these introductions should serve as tools of empowerment for populations typically left out of data-centered decision processes. We hope to move beyond the college classroom in future work, trying these activities out with community groups that work on issues of justice that involve data. The coronavirus pandemic limited our ability to start with these groups, and in-person workshop with them would remove the barriers of access to bandwidth and computers for online Zoom sessions.

These initial observations and examples present us with numerous potential next steps focused on exploration, formalization, and robustness. For instance, we could administer pre- and post-surveys at workshops asking participants about their confidence levels vis-a-vis working with data. This would ascertain whether a single experience with these activities creates a short-term impact on self-assessed abilities, and perhaps build an evidence base for overcoming skills-based identity barriers to working with data. Similarly, to explore the challenge of building empathy with subjects of data, we could more directly ask learners how connected they feel to the data and the performance they created.

Particularly related to creating impact on the audience, we believe there is more theoretical grounding from theatrical practice to explore. One path forward would connect more directly to the concept of “kinesthetic empathy” - the idea that audiences experience empathy by watching a performance (Martin, 1975; Reynolds & Reason, 2012). Another relates to further exploration of feminist theatre practice and the idea of creating spectacle via performance in public place. The work of the Women’s Street Theatre Group at the 1970 Miss World competition is an evocative example (Cowley et al., 1971). In addition, we could engage more directly with the Brechtian “dialectical theatre” approach of interrupting performance to engage the audience. A participant noted we could “think about not only how it can abstract from a situation but also how you can re-invite into that situation.”

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