

Cultivating Critical, Justice-Oriented Data Literacies in a Post-Truth World

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Abstract: What are pathways toward critical and just data literacies? Achieving critical and just data literacies is especially challenging in an ideologically polarizing “post-truth” world in which we confront a rising tide of misinformation and fake news, alongside discourse that denigrates politically conservative perspectives. Although reasoning with data is rooted in epistemic processes, the stances people take are—and should be—influenced by values, concerns about maintaining cultural group membership, and concerns about equity and justice.

Through a range of approaches, contexts, and age groups, the papers seek to illuminate how to help learners become adept at employing data interpretation conventions, scrutinizing the reliability of data representations, and examining whether data representations render humans and more-than-humans visible or invisible, central, peripheral, unidimensional, or complex. Jointly, the papers examine how to cultivate publics who make use of consequential data representations to negotiate their everyday lives, and who identify and resist datafied injustice.

Keywords: data science education, data literacies, justice, epistemology, axiology, post-truth

Overview and significance

An increasing number of education scholars and practitioners are concerned with how we cope with the rising tide of misinformation (O'Connor & Weatherall, 2019) and fake news in our ideologically polarizing, “post-truth” world (e.g., Barzilai & Chinn, 2020; Kienhues et al., 2020; Lewandowsky et al., 2017; Tabak, 2020; Zummo, 2021). Efforts to address these challenges typically involve focus on epistemic issues and reasoning (Chinn et al. 2020a, 2020b; Kienhues et al., 2020; Sharon & Baram-Tsabari, 2020). Research in this vein often considers the effects of ideological group membership and identity, emphasizing the power of co-construction (Feinstein & Waddington, 2020), or the overshadowing of evidence (Jost et al., 2018). A growing body of research and development, including two sessions from ICLS 2020 that were cancelled due to the COVID-19 pandemic (Arastoopour Irgens et al., 2020; Matuk et al., 2020), focuses on the role that *critical data literacies* can play in creating not only more educated publics, but also a more just world (see also Hardy et al., 2020; Van Wart et al., 2020; Zummo et al., 2021). In this session, we propose examining *how people integrate data, and uses of data, in their reasoning about ideologically-tinged “post-truth” debates, and the stances and positions they take across the lifespan*. Although such reasoning is rooted in epistemic processes, the stances people take are—and should be—influenced by values, concerns about maintaining cultural group membership, and concerns about equity and justice (Arastoopour Irgens et al., 2020; Polman et al., 2020; Walsh & Tsurusaki, 2018).

In this session, we seek to heed the call by Lee, Wilkerson and Lanouette (2021) for a humanistic stance toward data science education. We seek to recognize that multiple ways of knowing and being should ethically be supported. This involves recognizing the problems of Western science’s epistemic colonialism while also recognizing its potential; additionally, this involves seeking to avoid the traps of relativism. We therefore aim to recognize the role of power and politics, amid the severe and pressing social and ecological crises and injustices of our times, in which the histories, identities, and flourishing of certain humans and most more-than-humans (1) are marginalized, erased, and eradicated. At the same time, we recognize educational rhetoric focusing on “fake news” and misinformation often ends up denigrating politically conservative perspectives and those who hold them, creating dichotomies and increasing divisions without paving realistic ways forward. Therefore, we seek to answer the question: what are pathways toward critical and just data literacies?

All 9 posters share the grounding assumption that data representations are not simple or direct snapshots of states in the world, rather they are constituted by and they constitute ways of seeing and being in the world. This bi-directional process occurs through narrations of the data (Radinsky, 2020), an explicit or implicit theme in all of the posters. All posters also reflect a commitment to cultivating publics that feel able and entitled to engage in such interpretive processes, and that resist taking data representations at face value, investing instead in deliberative and critical processes (Tabak, 2020). Poster abstracts are listed below alphabetically by first author and referred to here by numbers in this sequence. Some of the posters, especially posters 2, 3, 5, 6, and 9 emphasize epistemic aspects: such as, what are conventions and means for reliable measurement and interpretation, how can alignment and misalignment with such conventions be discerned and assessed in consequential data representations. Some of the posters, especially posters 1, 4, 7, 8, and 9 emphasize axiomatic aspects, such as, how do data representations render humans and more-than-humans visible or invisible, central, peripheral, unidimensional, or complex; and how do representations serve or undermine justice. As a set, the posters integrate these aspects in considering what conventions should be adopted or taught, who should decide, and how can we productively balance conformity with contestation? By building on these shared assumptions and concerns but addressing a range of topics, disciplines, contexts and age groups, the session has potential to inform and appeal to a broad audience.

We propose a 90-minute structured poster session. The session will open with a brief introduction, followed by highlights of each of the posters to orient the audience to the full set. There will be two rounds of free-form time during which the audience can engage with the different posters; in each round, only half of the poster-presenters will be at their posters, to allow presenters to engage with each others’ posters as well. The session will conclude with two discussants, both with extensive research experience related to the ideas in the session—one discussant, Clark Chinn, will emphasize epistemic aspects, and another discussant, Thomas Philip,

will emphasize axiomatic aspects. There will be ample opportunity for audience active participation during the free-form segments, and following the commentaries.

1. “School. School. School. Home alone.” Promoting students’ critical media and data literacy through critique and design of narratives about teen time use.

Anna Amato, Megan Silander, Camillia Matuk, Jill Beale, Kayla DesPortes, Marian Tes, Ralph Vacca, and Peter J. Woods

Youth are often subjects, not producers of public data, which, as a result, can misrepresent their lived experiences (e.g., Lahusen & Kiess, 2020). How can ELA-integrated approaches to data literacy engage students in (1) identifying issues of youth representation in data and (2) in thinking critically about how data are produced and used (Gebre, 2018)? We collaborated with four urban public school teachers to design and implement an 8-day interdisciplinary unit investigating time use. Grade 7 students (N=80) examined arguments from news articles, documentary photography, social media, and the American Time Use Survey, and made inferences about how the (un)availability of time use data impacts representations of youth. Students then collected and analyzed data on their own time use. Qualitative analysis of participant interviews and artifacts showed how students reasoned about data and context, such as by reflecting on the impact of socioeconomic status and location on time use, making comparisons, and asking questions (“one kid might spend their time on the phone, another harvesting crop. Is one more valuable than the other?”). Students reasoned about the value of different data types for communicating meaning (“how would this [photographic] data look different if you presented it as numbers?”). They discussed sampling decisions and representation (“If we want a true and complete representation we would need more pictures”). They designed ways to sample their time use (“We can take photos of a teenager’s day every hour and it can tell us a day in the life of a teenager.”), attending to who produces data (“photos that teens take themselves”) and to describing data patterns (“School.School.School.Home alone”). Findings suggest that integrated ELA-math instruction can expand students’ ideas about data, support their critical reflection on data, and help them to generate ideas for representing their own experiences through data.

2. High School Students’ Conceptions of Climate Change and COVID-19 Data Presented in Infographics

Daniel R. Pimentel, Emily Reigh, Victor R. Lee, and Bryan A. Brown

Recent concerns about science misinformation (e.g., Barzilai & Chinn, 2020) and the increased use of data infographics in media sources (Polman & Gebre, 2015) indicate a need to understand how young people conceptualize and reason about data presented to them as evidence. Drawing upon Hammer and colleagues’ (2005) notion of epistemological frames and conceptual resources, our exploratory study examined the questions: 1) What epistemological frames are involved when students are asked to interpret and critique data from infographics about socioscientific issues? and 2) What conceptual resources do students use to engage in interpretation and critiquing tasks?

We conducted and recorded a think-aloud protocol using videoconferencing software. We observed 15 high school students while they interpreted and critiqued data in four different infographics; two about climate change and two about COVID vaccines. We then engaged in knowledge analysis (diSessa, Sherin, & Levin, 2015) to identify the frames and resources that students used to make sense of the data in each of these tasks. We illustrate that during interpretation tasks, most students primarily viewed data from a *representational* frame, positioning data as fixed and context-independent. When asked to critique, students tended to use a *relational* frame, viewing data as context-dependent and constructed (Leonelli, 2015). We argue that distinct resource sets and partial overlaps in conceptual resources determine whether students see the data represented in the infographics as authoritative or subject to critique. For instance, depending on the frame, students might treat data as correct and self-evident or as subject to error and personal bias. Further research should investigate how these frames might support critical data literacy practices.

3. Establishing trust relationships as a component of critical and just data literacies

Ilana Dubovi, Josh Radinsky, and Iris Tabak

We integrate findings from two studies examining how agency in everyday data practices is evinced not only through numeracy but through interpersonal experiences (Feinstein & Waddington, 2020; Tsatsou, 2018), mediated by trust relationships. These relationships can mitigate barriers to “the emancipatory process of

understanding and critically engaging with one's context" in a datafied society (Jansen, 2021). In highlighting trust as a target for research, we respond to calls for humanistic and relational approaches to data science literacy (Lee et al., 2021; Wilkerson & Polman, 2020).

Both studies focused on COVID19 information practices. One study surveyed 500 diverse (SES, education) Israeli adults; the other interviewed 6 adults (4 Israeli) about their data practices. STEM and social sciences [STEM+] survey participants were more likely than arts and humanities [AH] to reason with data about functional questions (e.g., should schools reopen). Trust (in science) was a significant contributing factor.

Similarly, STEM+ interviewees were versed in epistemic practices for approaching data with an air of "bending the representations to their inquiry will." Despite "following the lead" of the representations, AH interviewees critiqued data and took up new practices (e.g., attending to standardized ratios stating that they did so following the guidance of a trusted person). Trust relationships forged with friends, family and media personalities, who served as brokers of data literacy practices, supported taking up practices and feeling franchised to critique.

We cannot inoculate learners against fake news, but, like other educational responses to post-truth (Feinstein & Waddington, 2020), we suggest that a pathway toward fostering critical and just data literacies lies in helping learners to identify promising knowledge brokers and establish trust relationships.

4. Critical Data Practices within Community Infrastructuring for Survivance and Justice in the COVID-19 Multi-Pandemic

Day Greenberg, Angela Calabrese Barton, and Leslie Herrenkohl

In long-term research-practice partnerships, we investigated: How did youth engage in critical data practices (CDPs) in their out-of-school learning and action-taking related to COVID-19 and its intersections with in/justice?

We combine frameworks of critical data literacies and data justice to explore powered interactions among people and social structures that take shape through data. Data and data practices are never neutral nor independent of human thought systems. CDPs refer to data production, analysis, and sharing (Noble, 2018) to encounter/counter powered interactions and structures of harm (Philip et al., 2016) towards affecting lives, social relations and possibilities.

Using historicized and future-oriented participatory methodologies, we engaged in remote long-form dialogic interviews and experience sampling methods with 23 youth growing up in minoritized communities at three timepoints focused on: COVID-19 information accessed/applied towards decision-making; how efforts were situated within personal/community COVID-19 experiences/networks. We engaged in co-analysis with youth through practices of critical witnessing and being with, and oriented towards conscientization and social transformation of systemic inequities (Villenas, 2019).

We found that youths' CDPs involved efforts to recognize/leverage their intellectual power to engage, within community structures of support co-created in response to urgent shared need, including text and snapchat informational groups, grocery-redistribution networks, and extended family protection strategy sessions. These structures clustered and shifted dynamically in relation to data on the science of COVID-19 and health risks, safety, and social/emotional wellness. Youth also enacted alternative infrastructures for counter data production/aggregation towards community justice, amplifying community wisdom, and necessitating a reimagining of data sets and narratives as sites of struggle over what/who counts in COVID-19 data narratives. Youth navigated contentious spaces as data from different epistemological, social and political origins collided, necessitating new data engagement forms to navigate/transform spaces towards community survivance.

5. Data literacy and social design implications of algorithmic, socio-technical solutions to combating misinformation on social media

Eleni A. Kyza and Christiana Varda

In today's algorithmic-driven world, critical thinking is important for the evaluation of information on social media, where unvetted news abounds and potential misinformation lurks. Therefore, it is important to broaden our realm of inquiry to citizens and older adults and examine data citizenship perceptions and how artificial intelligence is being perceived and used (Hermes, 2006).

We conducted a quasi-experimental study with 80 adult participants to examine whether a socio-technical system — the Co-Inform co-created software browser plugin — supported misinformative-resilient actions, such as avoiding sharing or liking misinformation. We examined how participants reasoned about the big-data-driven interface, and the implications for the design of interventions to support evaluations of online information. We collected data on participants' actions and reflections when faced with misinformation on Twitter.

Analyses examined differences between the control and experimental groups (with/without the plugin) in terms of the participants' misinformation-resilient actions, as well as what prompted trust or distrust in the plugin.

Findings indicate that the experimental group (n=40) engaged in statistically fewer "likes" on misinformation; participants who trusted the software plugin were also less likely to share misinformation. Qualitative data analyses indicated that participants were critical towards the plugin, inquiring about dimensions of trustworthiness, such as transparency and explainability. Findings also point to insufficient understanding of the contemporary online mediascape, with participants overestimating their own abilities to evaluate the credibility of posts. These findings point to epistemic challenges relating to one's understanding of the digital world which should be addressed at multiple levels, and highlight the need for social design for addressing misinformation on social media (Pennycook & Rand, 2021). Such inquiries have implications for the design of sociotechnical systems and for school-based data literacy efforts.

6. Youth and the United Nations Sustainable Development Goals: Can Data Make the Global-Local Connection?

Andee Rubin

The seventeen UN Sustainable Development Goals (SDGs) (United Nations, 2021) are inspiring and far-reaching ambitions for a better world; they include no poverty, zero hunger, good health and well-being, and quality education. Youth (and adults) may feel these international goals are at a level they can't affect, yet middle school students often care deeply about such social issues. Perhaps data about how the countries of the world rate on SDGs can serve as a jumping-off point for youth to delve more deeply into local data around similar measures.

We document the design of NetApp Data Explorers, an out-of-school program whose goal is to support participants to move from a focus on international data on health and education to county-level data to more local and personal data and concerns. We describe both the particular design elements of the program whose purpose was to scaffold this journey and how participants navigated this narrowing and deepening of context. We focus on the influence of students' personal knowledge and experience in their interpretation the data and on the choices they made in "digging deeper" (Rubin, 2020, 2021; Lee & Wilkerson, 2018; Polman & Wilkerson, 2020). We also discuss data reasoning challenges that arose, including understanding how variability may be hidden when a rate is calculated for an entire country (e.g., in data such as "number of doctors per 100,000 people in a country") and untangling correlation and causation.

7. Developing Critical, Contextualized Data Agency through Educational Data Journalism

Stephen Sommer, Cynthia Graville, Joseph L. Polman, Andee Rubin, and Trang C. Tran

During a multi-year research partnership to cultivate data literacy amongst young people our team observed that in the course of doing journalistic work, many youth began to develop a critical consciousness about media, information, and data. Here we develop the concept of critical, contextualized data agency as a promising framework for an equity oriented approach to data education.

The concept of critical, contextualized data agency draws on a broad literature in the learning sciences related to individual and shared epistemic agency (Zimmerman & Weible, 2018) or learning agency (Barton & Tan, 2010; Damşa, et al., 2010). We build upon research related to learners' understanding and use of data actively contextualized and situated in their lives (Gebre & Polman, 2020; Lee & Wilkerson, 2018; Rubin, 2020; Wilkerson & Polman, 2020). We further add to these existing theoretical considerations an attention and emphasis on equity, social justice and critical or feminist data literacies (Arastoopour Irgens et al., 2020; D'Ignazio & Klein, 2020; Tygel & Kirsch, 2016)

We examine the development and manifestation of critical, contextualized data agency through two case studies. In a high school physical science class a student demonstrated a desire to communicate well-justified and actionable concerns to the public regarding growth hormones in livestock. In an after school program case, we document how another student took a global equity stance to argue for an expansive view of happiness beyond economics, and used data acumen to enhance and defend her arguments. Across these cases, we see the importance of cultivating agency to "speak truth to power," and how youth actively used data in contexts that emerged from their lives and contributed to imagining more just futures.

8. Forging Pathways from Computational Complex Systems Models to Current Socioscientific Issues Through Scientific Epistemic Practices

Susan Yoon, Clark Chinn, Amanda Cottone, Thomas Richman, Noora Noushad, and Huma Hussain-Abidi

The DeTECT project examines scientific epistemic practices of data use through computational complex systems models with a focus on transfer of those practices to evaluate controversial socioscientific issues. We are interested in the extent to which teachers and students are able to demonstrate adaptive epistemic practices (Chinn et al., 2020b). These include the ability to determine the veracity of claims based on fit with evidence and deciding which kinds of data are needed to construct accurate decisions in situated contexts. Scholars suggest that an education in epistemic practices requires expanded notions of disciplinary work (Brown, 2017) and highlight challenges in engaging teacher beliefs, improving skills and confidence in content enactments, and implementing pedagogies that afford student epistemic engagement (Buehl & Fives, 2016; Haverly et al., 2020).

We report on teachers' beliefs, enactments, and confidence levels with respect to teaching with curricula to improve student epistemic performance. Students worked with a computational model of gene regulation and examined variables (e.g., feedback loops) and data patterns that enable genes to be turned on and off due to environmental conditions. Students then applied this epistemic framing to current issues such as: data and research on CRISPR gene editing technologies and population disparities exacerbated by unequal access to them; or the intensification of climate change resulting from positive feedback loops and the disproportional impact on vulnerable groups. Preliminary results indicate that teachers hold strong beliefs about the importance of improving students' epistemic practices of data use and making broader connections to socioscientific issues. However, teachers also demonstrated challenges in translating those beliefs into practice, which are discussed in more detail in the presentation.

9. Storytelling with Data: A Syncretic Approach that Brings Together Social Justice with Middle School Science

Xinyu Wei, Cherise McBride, Michael Bakal, Collette Roberto, Emily Reigh, Puneet Bhargava, and Michelle Wilkerson

The Writing Data Stories project engages youth in learning activities that integrate computational data analysis and visualizations with personal testimony, interviews, and journalistic media stories. By facilitating middle school students to think more critically about social justice, the project encourages them to draw on evidence from their lived experience as a *syncretic approach* (Gutiérrez, 2008) whereby dataset exploration is deepened and contextualized through integration with personalized, multimodal "data stories" (Wilkerson et al., 2021).

We present evidence from a summer science camp on the U.S. west coast where grade 7-9 students explored the racially disproportionate impacts of COVID-19 and other health hazards. Reflecting on extended definitions of environmental racism (Holifield, 2001), students generated hypotheses through case studies, news stories, interviews with family members, and then explored publicly available datasets on the Common Online Data Analysis Platform (CODAP), a computational tool that helped them structure, calculate, filter, and transform data for scientific inquiry and argument (Erickson et al., 2019).

Through qualitative inquiry analysis, we found that students constructed oral and written presentations that contextualized data to highlight intersections of race, geography, health, and environment (Gutiérrez & Jurow, 2016). For example, several students reported the relationship between pollution burden and poverty level in the San Francisco Bay Area; others started advocating for social change after identifying particular communities most vulnerable to asthma. These findings illustrate emerging characteristics of sociocritical data literacy and center lived experience as valued sources of truth and axes for change. We propose that students' syncretic literacies enable them to publicly take a stance on urgent social issues by defining and debating environmental racism in and out of their science classrooms.

Endnotes

- (1) "More-than-human" is used among others by indigenous communities and scholars to refer to other species and beings in nature with whom humans should be seen as having kinship relations (e.g., Kimmerer, 2013)

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