Guest editorial: Special issue – perspectives on data literacies

For this Special Issue, we invited papers exploring current perspectives in learning and information research and data literacies education, addressing the growing need for a data literate society. People have become subjects of data, being thoroughly measured, tracked and analysed through their personal digital data created with everyday information and communication technologies. We live our lives in a data economy and many future job prospects hinge on the ability to participate and use datafied systems and processes, requiring the ability to read, analyse, reason with and argue with multiple forms of data (Bhargava *et al.*, 2015; The Federal Big Data Research and Development Strategic Plan, 2016; Symons and Theo Bass, 2017). Indeed, data literacy is not just essential for economic enterprise/security, it increasingly shapes learning, global public health, media, democratic participation and the creative arts. Contemporary data subjectivity, built on data traces and their near constant collection, affects people's most basic sense of autonomy and agency in life (Grafanaki, 2016, Pew Research Center, 2023). As well, there is a wide disconnect between the data practices of government and corporations and the data skills, knowledge and level of awareness of the general public (Qlik, 2019; Deahl, 2014).

Many people, whether young or old, have difficulty transferring an awareness of data into critical practice. For example, data literacies research with teens has shown that they have limited "data imaginations" when it comes to critical thinking about data (Pangrazio and Selwyn, 2021, 2017) and they find it difficult to connect with data at a concrete and personal level (Bowler *et al.*, 2017). Educators may face the same issue as teens. In work that looked at library-based learning about data, the library staff, although armed with a general awareness of datafication, used a confusing array of interpretations for data and data skills to describe data literacy (Bowler *et al.*, 2019). Such multiple approaches to data literacy (i.e. data literacies) highlight the need for more research that establishes precise definitions, frameworks and models and collaborates with teachers to develop responsive teacher training and "training the trainer" models.

Information researchers and learning science scholars argue that consideration of the socio-technical environment can contribute to contextualizing the scope and affordances of technologies used to make and meaningfully interact with data. For example, the ubiquity of mobile smartphones connected to the internet suggests that more inclusive and robust frameworks are needed for explaining the networked, distributed and multiple device and upgrade cycle into present-day understandings of data management skills (Acker and Bowler, 2018). We might also consider what data literacies education should look like in a world where algorithmic interventions are up-ending notions of human agency (Sefton-Green and Pangrazio, 2021).

Competence and deep engagement with data is a complex array of socio-technical skills, knowledge, quantitative and humanistic reasoning. This includes a set of dispositions that facilitate the ability to critique data practices, to contextualize data within platforms, cyberinfrastructure and society and to find meaning in data beyond statistical and mathematical arguments. However, such data criticism is not settled because the contexts for data practices continue to expand, shift and update. Importantly, this special issue shifts the frame from a one-size-fits-all account of literacy to *literacies of data*. We are in the early days of building a body of research and practical models on data literacies in pedagogy, design and use (Wolff *et al.*, 2019; Pangrazio and Sefton-Green, 2020). We need a clearer picture as to what theoretic approaches, pedagogy and curriculum best support knowledge

and understanding about data. Also needed are nuanced discussions about how the social, cultural, political and technical contexts of data, data justice and the datafication of everyday life inform data literacies pedagogy.

The scope of this special issue is broad, addressing teaching and learning related to data literacies in primary and secondary schools (K-12), community colleges and universities, including university-industry collaborations, as well as informal spaces of learning such as public libraries and among learners and publics of all ages. We deliberately framed this issue around data literacies (plural), recognizing that the field is cross-disciplinary, including information science, the learning sciences, education and science and technology studies. This new work offers data literacy frameworks, definitions and practice theories through a variety of lenses, such as critical theory, sociotechnical studies and other approaches appropriate to the topic of data literacies in varying information and learning contexts.

Broad themes to emerge

Several articles in the special issues on data literacies focus specifically on pedagogy and curriculum, presenting evidence-based examples of learning experiences, valuable practical guidance and critiques of existing practices in the field of data literacy education. Within that theme, three articles by Matuk *et al.*, Aleman and Zhou *et al.* explore data literacy curriculum with children and youth. Matuk, Vacca, Amato, Silander, Woods, DesPortes and Tes' article, "Promoting students' informal inferential reasoning through arts-integrated data literacy education", will be of interest to those seeking a humanistic, transdisciplinary and arts-oriented approach to data literacy. Matuk *et al.* created, tested and documented four data-art inquiry units – dance, photoessays, comics and collages – in middle school classrooms (with students, ages 11–13 years old). Through this integration of arts education and data science, the authors delve into the synergies and tensions in an arts-integrated data literacy education, explore how data-art inquiry can support informal inferential reasoning and offer practical recommendations for bridging the differing epistemic practices of the arts and sciences.

Ezequiel Aleman introduces a data literacy approach used with youth in an alternative secondary school, in their article, "Exploring alternative discourses about datafication in a speculative youth participatory action curriculum." Using a mixture of speculative fiction and real-life experiences revealed through participatory action research, the authors argue that a culturally devoid approach prevents youth from developing a critical stance on datafication in digital platforms. To fill this void, Aleman proposes a learning experience that asks youth to examine their personal relationship with data by way of an alternate reality game.

In their article, "Using network visualizations to engage elementary students in locally relevant data literacy", Zhou, Steinberg, Stiso, Danish and Kalani design and test six network visualization activities for students in grades five and six (10 and 11 years old), the goal being to develop an understanding of patterns in data. The authors conceive of network visualization competencies as a subset of data literacy. While not geared toward arts education as is the case of Matuk *et al.* above, the activities in Zhou *et al.*'s article build a visualization vocabulary (i.e. nodes, edges, connections) that help students interpret relationships in data.

While also focused on youth, Bowler, Lopatovska and Rosin explore interactions rather than presenting a curriculum or lesson plan for data literacy. The authors consider co-design with teens as not just a design method but also, a valuable learning space for data literacy in the public library: teens learn as they make. Using a natural language processing software tool, Bowler *et al.* explore the nature of teen-adult conversations as they design data literacy activities together. The article provides a novel method for assessing young people's engagement in data literacy education.

Turning to the college and university realm, McDowell and Turk's article tackles data literacy education through the integration of arts and data science in two data storytelling courses for college-level students. In their article, "Teaching data storytelling as data literacy", the authors present learning outcomes, key concepts and a program of lesson plans that teach visual and narrative communication skills, and how to analyse and communicate findings from data sets. The courses are framed by Pangrazio and Sefton-Greens' (2020) three data literacy pedagogy categories – formal, personal and folk – and thus contribute to a deeper understanding of emerging learning theory specific to data literacy.

How do universities know what data skills should be targeted in the education of their students? Eylem Tas, in the article, "Data literacy education through university-industry collaboration", tackles that question by considering the value of employers' perspectives. They argue that collaboration between university and industry will help to ground data literacy education in real-world needs and give students a realistic understanding of what working professionals are expected to know. Rather than set out a curriculum or series of lesson plans, Tas presents findings from interviews with private companies, government agencies and non-governmental organizations regarding essential data skills that should be targeted at university. Interdisciplinary approaches to data literacy education, according to the authors, would help students transfer and adapt data skills across domains and contexts.

Another theme that emerged in the Special Issue was the challenges and opportunities of critical data education. Several articles focused on educational approaches that apply critical pedagogy and analyses to understand and act on the power and politics of data. The key goal in these articles is to raise awareness of datafication by developing data literacies through innovative educational interventions. While the notion of "critical data literacies" has emerged in the academic literature over the last few years, there is still a lack of theorization of this concept as well as its practical application in everyday life. Taking up this challenge, Ina Sander presents a framework for theory and action in her article "Critical datafication literacy: A framework for educating about datafication." Theoretically the article draws on media literacy, the German "(politische) Bildung" and Freirean "critical pedagogy" to develop a practical model for educators. The study takes a novel approach, analysing the current data education programs available online, while also interviewing both creators of these programs and educators who use them. Based on these findings the article puts forward a framework for educating about critical data literacy that seeks to develop *systemic understanding* of datafication, which promotes critical thinking, informed choice and action.

Working with an under-researched participant group, Sarah Evans, Lingzi Hong, Jeonghyun Kim, Erin Rice-Oyler and Irhamni Ali investigated community college students' self-assessment of data literacy. The overarching purpose of their article entitled "Community college students' self-assessment of data literacy: Exploring differences amongst demographic, academic, and career characteristics" was to use the study to gather insights for the design and implementation of data literacy training programs for different groups of community college students. Their findings reveal the nuances of self-reported data literacies, with males reporting greater confidence in their data literacies, while high school graduates feel they lack proficiency. These results point to the need to tailor data literacy education more closely to the skills, dispositions and applications that students bring with them to the program and highlight a key concern for this Special Issue – that is, the need to approach data literacies in all its plurality.

Developing critical understandings of data with young people can be particularly challenging, as sharing data on social media is key to their ability to connect and communicate with peers. The final article in this theme, takes up this challenge by experimenting with innovative approaches to help young people critically reflect on their

data practices. Annette Markham and Riccardo Pronzato's article "A critical (theory) data literacy: Tales from the field" reports on 10 years of experiments working with more than 1,500 university students in Denmark, USA, Canada and Italy. It develops students' critical data understandings through self-oriented guided autoethnography, situational analysis, allegorical mapping and critical infrastructure analysis. Using multiple modes of intervention, the article reflects on educational approaches and strategies that have enabled both attitudinal and behavioural change. In doing so Markham and Pronzato develop a critical approach that complements and extends young people's everyday data practices and which are, therefore, likely to be sustained into the future.

Another thread of data literacy education examines privacy, data protection and personal data management. While the conception of a right to privacy has been valued since Warren and Brandeis (1890), the pervasive reliance of digital technologies that collect on data collection, surveillance and repurposing data collections for personalization create new datafication risks for individuals, but for society as well. For many decades, personal data protection has unfolded differently in many national contexts, however, regulation internationally has increasingly turned towards the limits of platforms, social media companies and the cross-border transmission in the collection and access of personal data. Priya Kumar's article, "Orienting Privacy Literacy Toward Social Change" situates privacy literacy within the broader frameworks of data literacy and critical perspectives of datafication in society.

By centring privacy awareness in social contexts, Kumar synthesizes a number of contemporary community and research collective examples where data literacy and privacy knowledge move beyond the responsibilities of individuals by shifting concerns for data privacy to a social dimension. Kumar argues that broader data privacy literacy and praxis must be focused on shared, social conditions where privacy and data are protected in social context so that regulation and policy, design processes, organizational shifts and advocacy to support communities.

Kumar's offering on privacy literacy complements another case study featuring personal data literacy from authors Raffaghelli, Romero Carbonell and Romeu-Fontanillas, who analysed more than 700 higher education student responses to "Terms and Conditions of Use" drawn from everyday learning technologies. This research highlights the daily trade-off that most individuals, but especially students and early-career professionals, face in protecting their personal data while successfully participating in learning and professional environments that rely on software and other digital learning tools. By examining participants' perceptions of Terms of Use, the authors draw our attention to the significance of individuals' ability to renunciate technologies in ensuring data privacy while considering the stakes of student as users of these technologies in contexts such as learning and workplace training.

By studying students' perspectives of data privacy involved in their own learning tools, researchers were effectively able to raise awareness in the data literacy intervention, however, the empirical evidence from participants' renunciation practices remained less clear due to the epistemic diversity and disciplinary training of this student population. Raffaghelli, Romero Carbonell and Romeu-Fontanillas provide a reflective discussion on the limits and implementation of methods applied for awareness interventions. They invite future researchers to incorporate cultural contexts and community relevance in the design of future work.

While data literacy has always concerned personal data collection, many of the authors in this special issue argue that broadening the scope of data literacy education should consider how data, once collected from users, is incorporated into algorithmic technologies,

personalized recommendation and data-driven technologies that rely on training data. In "Data Literacy in the EU DigComp 2.2 Framework: How DigComp defines competences on Artificial Intelligence, Internet of Things, and Data," authors Van Audenhove, Vermeire, Van den Broeck and Demeulenaere.

The DigiComp framework is a European competency framework to measure data literacy, that relies on the Data Literacy Competence Model (Seymoens *et al.*, 2020). In the framework's 2.2 version, the model expands to consider artificial intelligence and the Internet of Things among other new datafication technologies that shape data literacy. Authors present a broadened definition of data literacy drawn from the DigiComp 2.2. standard and unpack some assumptions about the necessary competencies measured. Authors find that the predominant focus in data literacy education is on using data but as efforts shift to understanding data connections to civics, ethics and equity increase. As others in this issue have similarly found, Van Audenhove, Vermeire, Van den Broeck and Demeulenaere note there is an increasing emphasis on media literacy to combat misinformation and disinformation, but a research focus on personal data protection and understanding data through privacy is still needed for new models of comprehensive and critical data literacy.

Moving forward
Our goal with this special issue was to survey the current state of data literacy education, theory and practice. As the title of this issue suggests ("Perspectives on Data Literacies"), we approached the problem from a pluralist point of view – our sense being that there is no one essential form of data literacy education. The articles in this special issue bear this out. Different domains of knowledge, from media studies to computer science, bring their own philosophical and aesthetic approaches to the problem space. This diversity of approaches also supports the notion that the concept of data is itself multi-faceted and contextual. Rather than calling for a unified approach to teaching data literacy, the articles in this special issue point to a rich diversity of methods that demand from teachers and librarians a deeper understanding of the data literacy landscape. At the same time, this special issue points to an exciting array of creative, meaningful theory, methods and practices for tackling data literacy.

Amelia Acker
School of Information, University of Texas at Austin, Austin, Texas, USA
Leanne Bowler
School of Information, Pratt Institute, New York, New York, USA, and
Luci Pangrazio
School of Education, Deakin University, Melbourne, Australia

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