



## **Perspectives on Youth Data Literacy at the Public Library: Teen Services Staff Speak Out**

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### **Abstract**

This paper reports on the second phase of a three-year ethnographic study project exploring teens and data literacy in the context of Teen Services in public libraries, with the goal of building an understanding of the potential roles that Teen Services staff (librarians and library workers) can play in supporting data-literacy competencies youth will need to have. We report on current research in the area of data literacy, teens, and public libraries. Then we describe our interview fieldwork, which focused on the perspectives of library staff working with adolescents. Findings in this paper draw from our formal examination and synthesis of interviews with thirteen Teen Services staff, working in five public library branches in a midsized urban city in the northeastern United States. Based on interview data, observational fieldwork, and synthesis from previous research, we report on five themes that emerged from the investigation and develop a model of youth data literacy based on the data life cycle. We argue for a holistic and humanistic approach to data in public library programming for youth that is aligned with broad, cross-cutting themes such as data infrastructures, data rights, and data subjectivity in order for Teen Services staff to have an impact and prepare young people for a data-driven world.

## Introduction

The lives of young people today are indelibly etched in data traces created with networked platforms supported through Internet-connected digital devices. They are growing up in a world of mass data collection—a world where data literacy is a critical aspect of citizenship in the twenty-first century. In order to contribute to future conversations about the role of data in their lives, in their communities, and in society, they will need to understand how data is gathered, aggregated, processed, interpreted, and managed. A data-literate teen will have the skills, knowledge, and disposition needed to understand data in their personal life as well as the in the contexts of data collections in the world in which they live. What can public libraries, and in particular, the people who work in Teen Services, do to prepare young people for this world? Although there is a robust and complex body of literature about digital youth and information literacy skills, data literacy at the public library is under-theorized and discussions tend to be focused on the more formal learning contexts of the K–12 classroom or higher education. There is little research examining data literacy through the informal learning context of public library programming or the potential roles that Teen Services staff (librarians and library workers) can play in supporting data-literacy competencies for youth. This paper presents the second phase of the “Exploring Data Worlds at the Public Library” research study, a project that examines data literacy at the public library. In the first phase, we explored teen perspectives on data.<sup>1</sup> This paper reports findings from the next phase of the study, focused on Teen Services staff, attempting to discover what public libraries can do to prepare young people for a data-driven world.

Drawing from data collected in interviews with Teen Services staff at an urban public library in the United States, the paper analyses the knowledge and assumptions that library staff hold about teens and data, and it explores ideas about how public libraries can best serve young people in terms of data literacy. In the next sections, we introduce relevant scholarship on the topics of teens, data, libraries, and data literacy. This literature is followed by our study’s methodology and the five themes that emerged from our data synthesis. We conclude with a prototype for a curricular model for data literacy programming for teens at the public library.

## Literature Review

### *Teens, Data, and Data Literacy*

Research on information and digital literacy is familiar territory for the world of Library and Information Science (LIS). However, a direct transfer of models, skills, and concepts from information and digital literacy to the new and emerging contexts of data is not necessarily sufficient. As a result, data literacy remains under-theorized, especially as it relates to children and teens. Where attempts to theorize around data literacy do exist, it is generally presented as a set of quantitative reasoning skills related to numeracy, statistics, and computation.<sup>ii</sup>

Research in the fields of LIS and the learning sciences has begun to investigate how teens interpret the meaning of data. Researchers have found that, like “information,” teens do not hold a universal understanding of “data”: For some, it is simply numbers in tables; for others, it is digital information.<sup>iii</sup> Gebre also found a mix of meanings when surveying twenty-seven secondary-school students, asking them to describe data.<sup>iv</sup> From the survey responses, he found that students’ understanding of the concept of data was, on the whole, limited to three contexts: (1) experiment and survey, (2) utility and usage information, and (3) numerical charts and graphs. Research has also found that teens are generally unfamiliar with the broader concept of personal data collections that result in digital dossiers. Although they understand that their online behavior leaves behind data traces across platforms, they do not seem to consider the implications of those collected traces for their future selves. In addition to gaps in knowledge about data-collection contexts, they may also lack a systematic understanding of data flows, platforms, and infrastructure.<sup>v</sup> Further, there is an affective dimension associated with young people’s relationships to data that may influence their decision-making around data.<sup>vi</sup>

Increasingly, secondary education has begun to emphasize students’ essential skills related to numerical data. According to many researchers, to be data literate, students need to be able to access, convert, manipulate, analyze, and evaluate data.<sup>vii</sup> Based on this definition, Schield distinguished data literacy from information literacy and statistical literacy, stating that data literacy is an essential component and requisite of the latter two literacies in the hierarchy of critical-thinking skills.<sup>viii</sup> Privacy literacy, a set of skills deemed necessary to alleviate concerns about data exposure in online environments, is also emerging as a key component of young people’s well-being.<sup>ix</sup>

A broader perspective on data literacy is reflected in Gray, Gerlitz, and Bounegru’s work in the area of data infrastructure.<sup>x</sup> Drawing upon the literature on data literacy, they propose a new concept: “data infrastructure literacy,” which includes the “ability to account for, intervene around and participate in the wider socio-technical infrastructures.” Instead of focusing on the skills needed to manipulate data sets, they argue for a systems approach to data literacy, highlighting not just discrete data-management skills but also a deep understanding of the infrastructures through which data is created, stored, and analyzed. In this way, data literacy can address broader societal concerns. While Gray, Gerlitz, and Bounegru’s work contributes an inventive expanded data-literacy model, it has not been developed specifically for teens, and the application of the model to a teen audience remains unexplored.

### *Data Literacy and Libraries*

Because public libraries are committed to addressing the everyday concerns and well-being of youth as citizens, a youth-focused data-literacy model is needed, particularly with respect to their digital traces collected over their lifetimes. This model should not simply be quantitative skills, but should align with the humanistic, community-oriented goals of the public library—a unique pedagogy for this place of informal learning. Currently, academic research libraries have begun to implement data-literacy programming. Typically, these models of data literacy focus on the management and use of data as a product of scholarly research<sup>xi</sup> and on the school library environment, which explores data skills primarily through the lens of statistics and visualization.<sup>xii</sup> Prado and Marzal have mapped core data-literacy competencies to a traditional information-literacy framework that includes understanding data, finding and obtaining data, reading, interpreting, and evaluating data, managing data, and using data.<sup>xiii</sup> However, this framework of core competencies is intended to provide a guide for the design of data-literacy instructional services in the academic libraries of higher education and the more formal learning contexts of expert scientific research training.

Carlson and Johnston’s empirical study, also situated within the academic library context, and more specifically in the STEM disciplines, investigates how university libraries can support graduate students’ development of data management and curation skills.<sup>xiv</sup> Their work identifies a set of twelve data information literacy competencies that touch on a range of tool-based and theory-based competencies that map onto the data life cycle: discovery and acquisition of data,

databases and formats, data conversion and interoperability, data processing and analysis, data visualization and representation, data management and organization, data quality and documentation, metadata and representation, and cultures of practice.

Both the Prado and Marzal study and that of Carlson and Johnston reflect the valuable perspective of the librarian in higher-education contexts and academic research environments. However, while the two studies contribute to an understanding of libraries' role in supporting the training and activities related to data literacy, their focus on academic libraries does not reflect the specific context of public libraries or the experiences and needs of teens. We suggest that work in the data-literacy field needs to be done in the context of life-wide learning beyond the academy. A powerful platform for developing such meaningful experiences with data may be in the interest-driven, nonformal learning that happens in the context of teen library services. In the realm of nonformal learning, public libraries are already providing learning experiences with data through digital media labs and youth hackathons, albeit indirectly and not as a planned outcome.<sup>xv</sup> For example, the Civic Data Zine Camp in Teen Services at Carnegie Library of Pittsburgh included activities designed to teach teens data concepts. As a result of this work with teens, the library staff offered four tips for teaching teens data literacy: (1) Don't focus on the technology, (2) use relevant or localized data, (3) form community partnerships, and (4) present the results to teens.

While models of data literacy remain rare, especially in the informal learning contexts of the public library and with regard to young people, there are no empirical models of how teen library staff conceive of data and data literacy and, critically, what they think teens know and understand about data. With this paper, we aim to examine teen library staff's understandings of data, teens, and data-literacy programs at the public library, hoping to provide solutions to the problems of practice that surround youth data literacy.

## **Methodology and Study Design**

In this exploratory research project, we are focused on discovery rather than testing and evaluation. Our goal is to gather empirical evidence, build models, and propose conceptual frameworks that will guide the development of data-oriented learning programs in Teen Services at the library. The study did not conduct a quality review of existing library services nor did it test library staff and teens against a predetermined set of standards because such standards do not

yet exist in terms of youth data literacy at the public library. Instead we looked for emergent themes in the practices and knowledge of library staff who work with teens. Gathering empirical data from their perspectives will inform the development of a youth data-literacy model that makes sense in the informal learning context of the public library.

Our analysis for this paper is framed by the following research questions:

1. What do Teen Services staff (librarians and library workers) understand about data literacy?
2. What data-literacy skills are currently supported through library services for teens?
3. What concepts, models, and competencies should guide the training of Teen Services staff in support of youth data literacy at the public library?

This paper reports on the second phase of research from “Exploring Data Worlds at the Public Library,” a three-year ethnographic study project on youth data literacy in the context of Teen Services at the public library, with the goal of building an understanding of the potential roles that teen librarians and library workers can play in supporting the data-literacy competencies you will need in the data-driven world. This paper reports on the perspectives of library staff working with teens (the first phase focused on the teens’ perspectives). Findings in this paper are drawn from our formal examination of ( $N = 13$ ) interviews with Teen Services staff, but we acknowledge that our analysis could, in a holistic way, also be informed by the project’s other data sources, which include our observations in the library, interactions with staff in twenty-seven data-literacy workshops for teens, and two focus group workshops with Teen Services staff at the library.

Over four months in late 2017, we interviewed thirteen adults (six male, seven female), all of whom worked as staff members at an urban public library system. Interviews were conducted in five library branches where the interview participants had dedicated roles in Teen Services as librarians, library assistants, or mentors. Most, but not all, worked in the teen-only technology spaces located throughout the library system. Interview participant names and job positions are not identified in order to protect identities. Each interview lasted approximately one hour, following a semi-structured protocol, and addressed concepts related to data literacy, such as data awareness, data agency, data subjectivity, and data skills, as well as affective themes related to teens’ engagement with data. These themes fit within a larger conceptual structure

driving this research project, which envisions data as an ongoing interplay between collections and community practices.

A research team of two primary investigators and two research assistants carried out the interviews. Once interviewing was completed, audio recordings were fully transcribed and anonymized with pseudonyms by research assistants. After data processing, data analysis commenced over four steps.

In the first step, three researchers read and reviewed the transcript corpora. A combination of inductive and deductive methods was then applied to code the data, using open coding techniques (deriving new codes that are grounded in the data) to discover facets of data literacy unique to the library staff (for example, the library staff's beliefs about data) and applying twelve base codes from a preexisting coding matrix that arose from the first phase of this project, in which we interviewed twenty-two young people. We used the coding matrix in order to be able to capture cross-cutting themes across the project. The twelve base codes include affective characteristics, data life cycle, data representations, identity, information technology, locality, metaphors, privacy, rights, skills and aptitudes, temporality, and values. As coding proceeded, the transcripts were annotated with memos, and relevant quotes were highlighted and identified. The three researchers then each prepared synthesis notes, drawing attention to broad themes they had seen in the data. This analysis stage lasted for approximately two months. Once the initial analysis had been completed, the research team shared their synthesis notes and coding and worked to formulate a set of preliminary overarching themes related to Teen Services staff, the results of which are discussed below. The names of the participants have been anonymized with pseudonyms.

## **Findings: Emerging Themes Related to Library Staff and Data**

Our starting point in this study was to gain an understanding of staff who work with teens at the public library and their perceptions about young people, data and data literacy, and problems of practice with regard to the library's role in preparing young people for a data-driven world. We tell their story through the lens of five themes that emerged from our analysis of the interview data with Teen Services staff:

1. What are data?
2. What is data literacy?

3. Data intermediaries.
4. Understandings about teens and data.
5. Data and the pedagogy of informal learning.

These themes highlight gaps in knowledge and areas in need of development but also strengths, opportunities, and a unique library perspective.

### *1. What Are Data?*

Our interviews with Teen Services staff began with an exercise in defining data. Wanting to capture the library staff's raw, unfiltered understandings first, we (the researchers) did not present our own definition. Although primed to expect some "data literacy" research at the library through a staff meeting or in-house communications, few of the library staff had a quick, comprehensive, and easy-to-understand definition of data. There was a tension across the interviews—how to see, understand, make sense of, or even name data when so much of it is invisible. Further, it was clear that the library staff did not share a single, universal understanding of what constitutes data. This was not unexpected. Borgman, a scholarly communications researcher in the area of research data management, has noted that the term data is "now in its fifth century of use" but has "yet to acquire a consensus definition."<sup>xvi</sup>

When describing data, many of the library staff referenced numeracy, statistics, scientific inquiry, and the visualization tools that allow you to interpret quantitative information (such as graphs, pie charts, and spreadsheets, for example). Interestingly, staff members also situated data in the context of library services. One library staff member defined data as "information," referencing the informational content in books at the library. Another referred to the data points that young people can earn through badging programs. Yet another spoke of the library as a "data hub"—as one aspect of collection management and library service to the community. Two staff members picked up on the "data hub" theme (although they did not use this specific term) and spoke of data in terms of collections. This would include data that libraries gather about their users and the data sets that they make available for the community as part of the city's extensive open-data initiatives.

Data as a resource or by-product of our individual digital footprint from the networked systems with which we live our lives, although mentioned by some interviewees, was initially not a key focus in terms of how the library staff think about data. The absence of a discourse

around personalized, individual digital traces was noted in many early interviews. However, as our interviews and focus groups proceeded, the staff did indeed show awareness about this type of identified data. One of the staff members nicely summarized the challenge of defining data:

I think previously when we thought about that [data], we probably just thought about it in terms of programming statistics and circulation, and I really feel like that's what it meant to us. We didn't think about it in the larger context of the world, about data in the community that you use to make decisions or . . . the data that you create and kind of leave behind for yourself in this much more digital world that we currently live in. And I think that as a profession, we have sort of struggled with how to have conversations about that with teens, because we really don't fully understand it. (Emily)

The broad interpretation of “data” and the gap between considering the mass collection of digital traces may impact the shape and overall goals of data programming for teens at the library. Indeed, the struggle that Emily identifies between meaning and collection contexts is personal. It might be helpful, as an exercise for library staff who work in the area of data literacy, to simply spend some time discussing with each other the nature of data, its collection contexts, and its relationship to personal identity.

## *2. What Is Data Literacy?*

After discussing definitions of data, participants were asked to explain what data literacy meant to them. For most of the library staff, data literacy is an ambiguous concept but not unheard of. This is an expected finding, given the wide range of meanings associate with the term “data.” Indeed, the broader educational, business, and personal technology communities are still sorting through what it means to be data literate. Most participants expressed uncertainty around data literacy, with one participant describing the ambiguity, “I’m not sure where to grab hold of it [data literacy]” (Terry). Occasionally, we found that interviewees used the term “data literacy” synonymously with digital literacy and quantitative skills. However, there was no single unifying understanding of the set of competencies associated with data or the purposes for becoming data literate. As a result, it was difficult for most participants to think concretely about how to apply data-literacy concepts to library programming and plan for outcomes.

To some of our participants, data literacy simply seems outside the realm of the public library. As one staff member explained:

[Data literacy] sounds like something really super serious and something that you would learn about in a classroom setting and, as you know, our programs and experiences with teens are often very informal and focused on relationship building and teen interest. (Emily)

Emily's characterization of informal learning and library relationships captures a powerful teen-centered approach to library services, but it also speaks to a very specific view of the competencies needed to live in a data-centric society. As this quote suggests, some staff members might be thinking that data competencies are best learned at school, at home, or possibly later, during adulthood.

Privacy is a strong theme that weaves its way through current perceptions of data literacy, with most participants mentioning conversations they have had with teens about internet privacy, social media use, and sharing passwords with friends. Ryan, a staff member in Teen Services, equated data education to crisis management, as a response to breaches in privacy and threats to personal reputation, but only after the event, not before.

As far as teen data, I think we talk about it when it comes up, you know, often when there's things like, you know, almost like crisis management, you know, like, have a discussion if someone shares something they didn't mean to share or someone shares something with other things and we try to help them collect and organize artifacts that will be personal to them.  
(Ryan)

Data literacy is just one type of competency in development at this public library system. In fact, library staff are tackling a broad range of literacies (from basic print literacy to computer literacy). Many participants discussed the variety of skills gaps that Teen Services staff are facing. These range from basic literacy (such as filling out your home address properly in a form) to the skills related to digital file naming and storing conventions (a skill relevant to the organization and preservation of data and digital records). Indeed, according to one staff member, some teens are not aware what a "username" and password are and how they are used to sign up for different platform services. The myth of "digital youth" creates an overconfidence in young people's digital knowledge that belies serious gaps in their understanding of personal computing technology and data infrastructures and that ultimately impact their ability to navigate data worlds. There is an interesting connection between digital skills and data literacy, captured by Liza in this quote where she talks about teens' perceptions of themselves as digital experts because of frequent phone or tablet use:

They [teens] are really confident because they can use the apps so well, and they are really comfortable with screens, and they're really comfortable with all the buttons and the way it looks and the feel of it, but they don't know the parts that they don't understand. And that can sort of lead to gaps that I find are dangerous, in terms of data on the internet. It would be helpful if the teens could know more about the landscape of data, especially the digital devices today have become foggier than it used to be. I think this is a very important point about data literacy. . . . The more they can understand the structures in place, even if they don't know how to do certain specific things, I think if just the landscape of data was more accessible to them (Liza).

This comment speaks to a broader contextual approach to data. The same staff member pointed out that teens don't properly save the digital creations that they make at the library because they don't understand how file systems work.

I think it has a lot to do with mobile phones. They don't really have a need to look at file systems anymore. That notion that a computer is built on a file system is sort of gone. It's just like, "a computer is a thing I interact with that has stuff on it." (Liza)

Indeed, this behavior was confirmed in our fieldwork with teens, where we found evidence that youth who use mobile phones and tablets as their primary computing devices don't have a strong grasp of file formats, file directories, or differences between local and cloud storage. It is clear that this lack of knowledge related to personal data management and ownership over data is connected to mobile computing and app-driven platforms. Increasingly, apps live at the atomic level of formatted information, and the conception of a "file" or even a format is not well understood by youth. Many of the library staff commented on this but didn't see this as an encounter with data, but rather as a misunderstanding of, or carelessness with, thumb drives, which were frequently given to teens to store files and almost as frequently left in public terminals. Understanding the principles of file structure relates to the management of data in the data life cycle, and it connects to our understanding of platforms, devices, even networked services. This suggests that library staff need to adopt a multi-prong approach, tackling basic digital skills even as they work to introduce data creation, collection, and management to young people more familiar with app-driven computing contexts.

These interview excerpts from the library staff also speak to a broader systems-oriented approach to data literacy at the public library. They capture the interconnectedness between data,

platforms, devices, and information infrastructures—representing a knowledge that goes beyond numeracy, statistics, and the data-wrangling skills associated with data collection, representation, preservation, and translation. While all of the library staff with whom we spoke evinced a strong belief in serving teens where they live, on their own terms, the nature of the technology adopted and used in library programs didn't always reflect this philosophy. For example, if the data that teens produce is largely transmitted through their smartphones, then a large portion of data literacy should relate to their personal computing environments at home, school, the library, and elsewhere.

While our participants did not have a definitive, uniform sense of what data, data skills, or data competencies might mean for the library, each demonstrated a great interest in learning more. They were hopeful and excited about the library's role in shaping people's experiences with new technologies and data skills. As one participant said, "It's cool being part of the library during this period where we're kind of transitioning and trying to keep that spirit of information, but still welcoming new technology." In our conversations with staff, there was a strong correlation between data and technology, and therefore, as one library staff member expressed, a perfect fit for the current direction of their library: "I think of it [data] as being connected to technology . . . and that's the labs for us" (Samantha), referring to a special technology space for teens at the library.

### *3. Data Intermediaries*

During our interviews with participants, the staff in Teen Services envisioned four roles for themselves as intermediaries at the public library: data conversationalists, data teachers, data agents, and data hubs.

*Data conversationalists:* This first role relates to interpersonal interactions and discourse around data topics. One staff member considered how data connects to the mission of Teen Services and their technology spaces for teens, saying that spaces where data is explored should be a safe space to hang out, to talk and discover—implying that explorations into data can contribute to the library's ethos of relationship building. These relationships are built on discourse between library staff and teens. It is in the context of these conversations that young people can gain insight into data, which may or may not be embedded into library activities that are explicitly data-oriented. For example, one of the participants mentioned casual conversations

with teens about social media, targeted political ads, and “scary” and “interesting” advertising technology to delve into the ways that personal data is collected and repurposed by data brokers. Library staff who work as facilitators between teens and data need to consider both the content and tone of their interactions. Should they be boosters, scaffolding pathways toward data empowerment, or should they be alarmists, sounding the alarm on data incursions into private lives?

*Data teachers:* Facilitating conversations around data can lead to learning, but even though a lot of learning in libraries happens informally, direct instruction is usually implied when we think of a librarian as teacher—someone who plans a learning activity with a specific outcome in mind and then leads the instruction (or facilitates the activity). The library, according to Jorge, a Teen Services staff member, has an obligation to teach the public about data and how it applies to them as an individual, calling it “a very noble cause” for the library.

*Data agents:* At least two staff members thought that it is the role and responsibility of the library to protect the library user’s data and privacy, in particular, user data associated with borrowing materials. In this protective role, the library serves as the public’s data agent. The staff members noted that the library doesn’t share user data without permission, nor does the library share young people’s images on the library’s media outlet without permission. In this study, we didn’t ask a specific question about how the library guards user privacy, so we don’t know if this is general knowledge for all library staff members. Nevertheless, we found it interesting that the participants—teen library staff—extended their understanding of themselves as data intermediaries to include the data that the library produces.

*Data hub:* This is a collections-oriented perspective. One might call it a traditional stance to intermediation because it focuses on the curation and reference roles of the library in helping the public gain access to and share data (usually publicly available civic or scientific data). As one participant explained, “To a librarian, it’s like how to access the data and how to share it with an interested person” (Jorge).

#### 4. *Understandings about Teens and Data*

What do the library staff think about how young people interact with data? What are their assumptions about teens and data? Responses were mixed. Some frankly said they didn’t know what was going on with teens and data (“I don’t know what teens’ relationship to the idea of data

is in the first place”—Olivia). We surmise this is because young people’s digital footprints are related to the use of their personal devices, which are outside the purview of the library. Other staff members thought that teens know more about data than we give them credit for, a belief perhaps gleaned in part through their interactions with teens at the library. One interview participant hypothesized that teens likely have a good level of basic data awareness but an even higher level of data skills, because they are savvy when it comes to the visibility location and tagging data in social media platforms.

We asked the staff about teen awareness of themselves as data subjects. One staff member speculated that teens’ particular self-orientation (their “selfishness” or egoism) gives them an advantage over older technology users because identity building is such a big process during teen years. The staff member reasoned that this central thrust of adolescence—identity building—can be leveraged to give them a sense of agency or ownership over their data. Another staff member observed that teen identity is always being expressed in the library, saying, “Any sort of activities that we do, the teens sort of do their own thing. Everything, every sort of program we have, is an opportunity to express their identity” (Jorge). If we follow this argument, then data-oriented activities at the library could quite naturally facilitate teens’ self-awareness of themselves as data subjects.

Discussion about teen awareness of data turned toward themes of privacy protection. A few interviewees suggested that each of us who uses the internet or digital tools has a “data self” made up of our digital footprint. In response to a question about data traces, one staff member spoke about teens and the data they create at the library, suggesting that their lack of privacy strategies, rather than reflecting a gap in knowledge, reveals how much they trust the library environment as a safe space to connect with different people and ideas. As Lauren explained:

I can think of instances when people have actually left their handles on whiteboards. We try to erase those so that not anyone can just access that. And then even related to people leaving their belongings unattended. It’s kind of a similar thing where they feel safe in the space and they’re like, “I want people to connect with me. I want to get more views.” Or whatever. I think that is probably the impulse and then less of an awareness that that could be not a positive thing. (Lauren)

Overall, when thinking about teens and data, the interview participants were exceptionally teen-oriented. They were strong advocates for meeting teens where they are in life, for finding

meaningful ways to relate data to teens' daily lives and their communities, and for making data concepts practical, rather than theoretical.

### *5. Data and the Pedagogy of Informal Learning*

There are few equivalents in the public library world to the type of assessment and certification of learning that happens in the K–12 environment or in higher education. Learning theories and practices developed in the context of formal learning do not necessarily apply to the library. This project is trying to resolve a problem unique to the world of unstructured library learning: how to ensure meaningful and successful learning experiences about data in an environment where interactions with the institution are not obligatory (as they would be in the K–12 setting). In such a space, planning for sequential learning experiences, critical to some STEM learning, is problematic. A key strength of informal learning, however, is that its primary goal is meaningfulness—learning that takes into account the sociocultural context of the learner and that is driven by the interests and motivations of the learner.

Informal learning experiences depend heavily on the library staff's deep knowledge of the people and community they serve. In our interviews with the Teen Services staff at the library, we saw that they do indeed have an admirable knowledge and sensitivity to their local communities, especially as relates to youth. To a lesser degree do they understand the pedagogy of informal learning. What might a knowledge of models of learning and theories of practice for informal learning environments look like? It would include a basic understanding about the psychology of motivation and interest, situated cognition, and the social construction of knowledge (for example, shared family knowledge, the influence of peer groups) as well as knowledge of various models of mediation and facilitation beyond the traditional classroom. We do note that two members of the library staff specifically mentioned connected learning in their interviews, a conceptual model and practice framework that draws upon this body of learning theory and that has been applied to informal learning spaces for teens, especially in relation to digital making.<sup>xvii</sup> Other teen staff members may have been aware of connected learning, but we did not specifically ask about it in the interviews. Nevertheless, continued professional development around connected learning would be useful but with the proviso that thus far connected learning has not made explicit connections to data literacy and youth in public libraries.

## Discussion

### *Understanding Data and the Data Life Cycle*

The principal lesson learned in this project based on three years of fieldwork with teens, library professionals, and public libraries is that there seems to be no single definition for data literacy, nor is there a simple “plug and play” recipe to help guide library programming around data-literacy competencies. The library staff in Teen Services identified a range of interpretations for data and data skills, including the following:

- quantitative data and associated reasoning, technical and computer skills;
- digital data, the footprint that teens leave online, and the associated social skills;
- data as a tool for artistic expression through data visualization techniques;
- civic data to empower citizens and enable social justice;
- library user data as a management tool.

The ambiguities about what constitutes data and data literacy, we think, hamper purposeful, intentional design of data-oriented library services and ultimately the impact that these services will have on the community. One way to accommodate the messiness that surrounds data literacy is for library staff to work together toward a definition of data. A conversation launched on a discussion board with the question prompt “What is data?” or perhaps a workshop designed to explore various types of data might help staff achieve a shared understanding that makes sense in the context of their own capacities, interests, and community.

Another approach is to think less in terms of the format of data (for example, a set of numbers, a table, scientific notes, digital traces, and so on) and more in terms of data as part of a system, situating data activities at the library within the broader concept of the data life cycle. All of the interpretations of data listed above could fit within a data life-cycle model. The library staff, however, were not always clear on how to align these forms of data to specific skills and learning outcomes. This may be because one type of data can be treated in many different ways, depending on the place within the data life cycle. When K–12 schools address data literacy, they do so with the specific curricular needs of the local school, school district, and state standards. But learning in the public library is more fluid and needs to be framed around a conceptual model rather than a hierarchy of standards. Working with a data life-cycle model may help to scaffold intentional outcomes with regard to data literacy.

Data has a life, much like information: it is created, collected, wrangled, visualized, curated, preserved (or destroyed), stored, interpreted, translated, used, and shared. Each stage is associated with specific skills and tasks. Librarians are familiar with the notion of an information life cycle, and therefore it should not be difficult to adapt this approach to their work with data at the library. By seeing discrete data-oriented library activities as just one piece in a larger data story, librarians can build programming that presents a rich picture of data, one that flows in a logical manner and helps teens build a strong conceptual understanding of data.

A data life-cycle model could be expressed simply as four phases—collect data, describe and organize data, preserve data, and transform and use data—each representing a phase in the life of data. (For the sake of simplicity, we have represented the data life cycle as if it is a neat step-by-step process, but in actuality, phases can be concurrent and iterative, and the activities associated with each stage can be built out considerably.) We note that the data life cycle is reflective of other common models in the data field and mirrors the actual practices of professional data stewards/data curators.<sup>xviii</sup> Conceptual models are useful tools because they bring intentionality to practice and help practitioners plan outcomes that impact people and community. Models can also point the way to gaps in programming. If the model was presented to teens, it might also help them understand the various roles and formats of data with more clarity.

### *The Context of Data: Cross-Cutting Themes*

The library staff who participated in this study often referenced broader themes and issues in their discussions around data and data literacy. From their practical interactions with teens and data, they realized that data sits within a broader context of community, society, technical platforms, institutions, and infrastructures. And throughout all these contexts, data connects back to the individual.

Library staff can help teens make connections between data and “real life,” where teens can give personal meaning to data. Teens can learn about the socio-technical ecosystem that structures data practices, the goal being to build a critical consciousness about data rather than a mechanistic approach to data management. Based on our observations and interviews with the library staff and in our other studies with teens, we note the following cross-cutting themes that

could be used to frame data-oriented programs for teens, even as those programs focus on specific skills and actions within the data life cycle:

1. *Teens' lives*: everyday encounters with data, data subjectivity, and personal identity; the capacity for social questioning and critical practice.
2. *Community, culture, and society*: local events, situations, people, policy.
3. *Institutions, infrastructures*: data flows across telecommunications networks.
4. *Platforms and devices*: technical prowess with specific applications, platforms (such as Instagram), and devices.
5. *Ethics, rights, and agency*: privacy and surveillance, digital citizenship, rights as citizens of a country, rights as proposed in the United Nations Convention on the Rights of the Child.

This approach aligns with Gray, Gerlitz, and Bounegru's call for a data infrastructure literacy, which includes the ability to disassemble data infrastructures in order to "account for, intervene around and participate in the wider socio-technical infrastructures through which data is created, stored and analysed."<sup>xix</sup> We recommend a similar holistic approach to youth data literacy—one that touches on actions within the data life cycle while also weaving context and cross-cutting themes throughout (over a series of activities, not in a single activity). In this way, young people can gain "hard" data skills along the full data life-cycle continuum, while also learning about the socio-technical world that surrounds data.

### *Library Staff as Data Intermediaries*

Thinking holistically about data suggests a range of mediating roles for library staff and a range of outcomes for teens. Indeed, the library staff reflected this positionality to data in the way they envisioned various roles for data intermediaries at the public library: as data conversationalists, data teachers, data agents, and data hubs. This suggests, again, a certain ambiguity around data but also, perhaps more hopefully, that there are many opportunities for library staff to engage with data. Not every staff member working with teens will be adept at reading and writing CSV files in Python. But they may be able to have a conversation with a teen about their rights as a citizen living in a data-saturated world.

## **Conclusion**

As we discovered in this project, there are multiple perspectives on data and data literacy, a situation that prevents a one-size-fits-all approach to library programming around data for young people. We suggest using a holistic and humanistic approach to data, an approach framed around the concept of the data life cycle, which is then aligned to broad, cross-cutting themes such as data infrastructures, data rights, and data subjectivity (to name a few). To navigate this complex world of data, teens do need technical, conceptual, and analytic skills to create, collect, manage, and curate data sets, but they also need a critical awareness of the broader social impacts and opportunities created by data. The library staff who participated in this study brought their interest in youth and a sensitivity to the real-world situations where young people interact with data. They have an important role to play in helping teens understand the data life cycle with more clarity, to see that data is not ephemeral but that it has material meaning in their daily lives and that it has the ability to shape their identity, connections, and agency in the world.

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## Notes

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<sup>i</sup> In the first phase of data analysis, we investigated teen perspectives. Findings were reported on aspects related to data awareness, data creation, ownership, and affective states. Amelia Acker and Leanne Bowler, “What Is Your Data Silhouette? Raising Teen Awareness of Their Data Traces in Social Media” (International Conference on Social Media and Society, July 28–30, 2017, Toronto); Amelia Acker and Leanne Bowler, “Youth Data Literacy: Teen Perspectives on Data Created with Social Media and Mobile Device Ownership” (Hawaii International Conference on System Sciences [HICCS], January 3–6, 2018, Waikoloa Village, Hawaii); Leanne Bowler, Amelia Acker, Wei Jeng, and Yu Chi, “‘It Lives All Around Us’: Aspects of Data Literacy in Teen’s Lives,” *Proceedings of the Association for Information Science and Technology* 54, no. 1 (2017): 27–35; Yu Chi, Wei Jeng, Amelia Acker, and Leanne Bowler, “Affective, Behavioral, and Cognitive Aspects of Teen Perspectives on Personal Data in Social Media: A Model of Youth Data Literacy,” in *Transforming Digital Worlds: 13th International Conference, iConference 2018, Sheffield, UK, March 25–28, 2018, Proceedings*, ed. Gobinda Chowdhury, Julie McLeod, Val Gillet, and Peter Willett (Cham, Switzerland: Springer, 2018), 442–52.

<sup>ii</sup> See, for example, G. Gunter, “Building Student Data Literacy: An Essential Critical-Thinking Skill for the 21st Century,” *Multimedia and Internet @ Schools* 14, no. 3 (2007): 24; Mark Van ’t Hoof, Karen Swan, Dale Cook, Tina Stanford, Philip Vahey, Annette Kratcoski, Ken Rafanan, and Louise Yarnall, “A Cross-Curricular Approach to the Development of Data Literacy in the Middle Grades: The Thinking with Data Project,” *Middle Grades Research Journal* 7, no. 3 (2012); Kirstin Fontichiaro and Jo Angela Oehrli, “Why Data Literacy Matters,” *Knowledge Quest* 44, no. 5 (2016): 21–27.

<sup>iii</sup> Bowler, Acker, Jeng, and Chi, “‘It Lives All Around Us.’”

<sup>iv</sup> Engida H. Gebre, “Young Adults’ Understanding and Use of Data: Insights for Fostering Secondary School Students’ Data Literacy,” *Canadian Journal of Science, Mathematics and Technology Education* 18, no. 4 (2018): 330–41.

<sup>v</sup> Lia Emanuel and Danaë Stanton Fraser, “Exploring Physical and Digital Identity with a Teenage Cohort,” in *Proceedings of the 2014 Conference on Interaction Design and Children* (New York: ACM, 2014), 67–76; Bowler, Acker, Jeng, and Chi, “‘It Lives All Around Us’”; Acker and Bowler, “Youth Data Literacy”; Luci Pangrazio and Neil Selwyn, “‘It’s Not Like It’s Life or Death or Whatever’: Young People’s Understandings of Social Media Data,” *Social Media + Society* 4, no. 3 (2018): 1–9.

<sup>vi</sup> Chi, Jeng, Acker, and Bowler, “Affective, Behavioral, and Cognitive Aspects of Teen Perspectives on Personal Data in Social Media.”

<sup>vii</sup> Milo Schield, “Information Literacy, Statistical Literacy and Data Literacy,” in *IASSIST Quarterly* (Summer/Fall 2004): 6–11; Gunter, “Building Student Data Literacy,” 24.

<sup>viii</sup> Schield, “Information Literacy, Statistical Literacy and Data Literacy.”

<sup>ix</sup> Katie Davis and Carrie James, “‘Tweens’ Conceptions of Privacy Online: Implications for Educators,” *Learning, Media and Technology* 38, no. 1 (2013): 4–25; Wouter M. P. Steijn and Anton Vedder, “Privacy under Construction: A Developmental Perspective on Privacy Perception,” *Science, Technology, & Human Values* 40, no. 4 (2015): 615–37; Sonia Livingstone, “Children: A Special Case for Privacy?,” *Intermedia* 46, no. 2 (2018): 18–23.

<sup>x</sup> Jonathan Gray, Carolin Gerlitz, and Liliana Bounegru, “Data Infrastructure Literacy,” *Big Data & Society* 5, no. 2 (2018): 1–13.

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- <sup>xiii</sup> Prado and Marzal, “Incorporating Data Literacy into Information Literacy Programs.”
- <sup>xiv</sup> Carlson and Johnston, *Data Information Literacy*.
- <sup>xv</sup> June Abbas and Kyungwon Koh, “Future of Library and Museum Services Supporting Teen Learning: Perceptions of Professionals in Learning Labs and Makerspaces,” *Journal of Research on Libraries & Young Adults* 6 (2015); Erica Deahl, “Better the Data You Know: Developing Youth Data Literacy in Schools and Informal Learning Environments” (MA thesis, MIT, 2014); T. Dankowski, “Engaging Civic-Minded Teens: Data Literacy Fosters YA Participation and Innovation,” *American Libraries* 49, nos. 3–4 (2018): 39–41.
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- <sup>xvii</sup> Mizuko Ito et al., *Connected Learning: An Agenda for Research and Design* (Irvine, CA: Digital Media and Learning Research Hub, 2013).
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- <sup>xix</sup> Gray, Gerlitz, and Bounegru, “Data Infrastructure Literacy,” 1.