



Assessing the Value of a Fellowship Program and Community of Practice at the Intersection of Data Science and Library and Information Science

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abstract: The intersection of Data Science (DS) and Library and Information Science (LIS) is rapidly developing, with a notable need for ongoing transdisciplinary training between practitioners in these two fields. The LIS Education and Data Science Integrated Network Group (LEADING) fellowship program and its ancillary community of practice (CoP) showcase a unique response to this continuing learning need. In order to assess the impact of the fellowship and CoP, this study utilized a sequential mixed methods design, which adapted the value creation framework (VCF) to examine participants' engagement with, and their perceived value of, their LEADING experience. Using the five indicators of the VCF (immediate, potential, applied, realized, transformative) and DEI-centered values, the study results show clear evidence of themes that are reported in the literature as highly influential in CoP value perception (connectedness, emotional engagement, and community values).

Introduction

Data science gained recognition as an academic discipline discrete from computer science in the 1990s and early 2000s, which makes it a relatively young and rapidly developing area of scholarly study and practice.¹ As new disciplines emerge, a key challenge is cross-domain collaboration between researchers in related fields, where the methods and research questions in the emergent area influence and are

portal: Libraries and the Academy, Vol. 24, No. 4 (2024), pp. 807–846.

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influenced by more established academic disciplines. In this case, some see significant overlap between library and information science (LIS) and data science (DS), while others hesitate to align these two areas.² In 2015, Elaine Martin issued a call for action in LIS, arguing for the important role librarians should play in DS. She said she feared that “data science is an evolving academic discipline being defined solely by computer science and that the field of library and information science is being left behind.” She contended that the “principles and values of the field of library and information science that form the core of...[the] profession need to be part of this new discipline and that...[librarians] can add unique perspectives and roles... These values include: focus on the user, user needs and user behavior, an ethical base, a penchant for collaboration and equal access to all types of information.”³ Others shared Martin’s belief in the essential link between LIS and DS, including Chris Erdmann, the head librarian of the Harvard-Smithsonian Center for Astrophysics, who created the experimental course *Data Scientist Training for Librarians* (DST4L) in 2015 with the aim of training librarians to respond to the growing data management and analysis needs of their communities.⁴ Discover Data Science, a site owned and operated by John Wiley & Sons to promote DS education, draws more specific connections between the work of librarians and data scientists by stating that “librarians, who are trained in knowledge organization and management, and who are adept in explaining how to take advantage of and organize information sources, are perhaps the best candidates to help address the shortage of data scientists. As data science continues to become more commonplace across all industries, the world will need citizens who can not only conduct data science inquiries but can also collect, organize, process, and deal with the raw data.”⁵

In the intervening years since Martin and Erdmann called for greater alignment between LIS and DS, data science applications have proliferated in the private sector and many academic libraries have created research and data curation departments. Indeed, the focus in libraries on creating data services became a key factor in the emergence of data librarianship as a distinct specialty within the field.⁶ Thus, a transdisciplinary specialty where a new discipline—DS—influenced and was influenced by an established one—LIS.

Background

The study discussed in this article is situated within this context, where there is an ongoing and growing need for DS expertise in the LIS field, and there are several ways in which LIS students and professionals can build this expertise, including participating in courses and fellowships. This study focuses on participants in two fellowship programs funded by the Institute for Museum of Library Services (IMLS) with Drexel University serving as the primary institution. The LIS Education and Data Science for the National Digital Platform (LEADS-4-NDP, or simply LEADS) fellowship program was funded for two years from 2018 to 2019, and the LIS Education and Data Science Integrated Network Group (LEADING) fellowship program was funded for three years, from 2021 to 2023.⁷ The LEADING program’s model includes community hubs at the UC San Diego Library and Montana State University Library (replaced in 2022 by University of New Mexico Library), a co-educational hub at the Online Computer Library, Inc. (OCLC), and 18 project mentoring sites.⁸ Drexel University’s Metadata Research



Center serves as the central coordinating hub for all project sites and oversees the data science curriculum for the fellows. This program has the goals of fostering collaboration and community development as well as facilitating diversity and inclusion to enable “a culture of mutual growth and continued sharing across the LEADING network...to advance data science in LIS education and practice.”⁹ From these goals arose the desire for a community of practice (CoP) that might engage both current and past LEADS and LEADING participants in continued social learning.

Using a cohort fellowship model, the LEADING program offers approximately 25 fellowships each year. Fellows receive training in DS and work closely with a mentor and project team on an information and data science project for approximately six months.¹⁰ Throughout the fellowship, the LEADING hubs aim to build community through a range of interventions including mentorship, shared learning, discussion groups, and research collaboration. Following the fellowship, the program seeks to keep fellows engaged by building a broader CoP at the intersection of LIS and DS.

Problem Statement

Building data science skills into librarianship is a key issue facing the profession, and the rapid growth in applications for data science will necessitate ongoing transdisciplinary learning on the part of scholars and practitioners. While there are numerous continuing education opportunities available to those interested in the intersection of these two fields, an understudied area is how valuable participants find the education opportunities available and how they remain engaged in DS and LIS learning after their initial training is complete through a community of practice or other means. A greater understanding of these issues could assist in improving the educational opportunities currently available, which may both increase the number of professionals interested in this transdisciplinary area and keep them engaged in the long-term.

This study explores these issues by focusing on the participants of one fellowship program and its ancillary community of practice, which seeks to provide both the DS and LIS initial training and continued learning. Additionally, given the lack of diversity in LIS, the program’s goal of facilitating diversity and inclusion while building community was also seen as an important area of inquiry.¹¹ Thus, the following research questions guided this study:

1. Which aspects of the LEADS or LEADING fellowship program and community of practice, if any, do participants find valuable?
2. To what extent, if any, do LEADS and LEADING participants believe that the program is inclusive, equitable, and diverse?

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In order to investigate the perceived value mentioned in the first research question, the authors employed the value creation framework (VCF), a conceptual framework for assessing the value created in CoPs, which was initially put forth by Etienne Wenger, Beverly Trayner, and Maarten de Laat in 2011 and was later expanded upon and refined by Beverly Wenger-Trayner in 2014.¹² The VCF will be discussed in greater detail in the following literature review section.

Literature Review

Given the interdisciplinary nature of the LEADING CoP, there are several bodies of literature that should be consulted in order to provide this article with appropriate context. Exploration of the research on CoPs in general, as well as CoPs in both library and information science and data science, is necessary, as is an overview of evaluative measures for CoPs broadly, and how the VCF has been applied in other fields.

Development of Communities of Practice

Communities of practice are “groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.”¹³ The concept may be age-old, but the term community of practice was first coined in 1991 by cognitive anthropologist Jean Lave and educational theorist Etienne Wenger in their co-authored work, *Situated Learning*, when they studied apprenticeships as a learning model.¹⁴

Since the 1990s, the concept of CoPs has flourished in a number of sectors, including governmental and non-governmental organizations (NGOs), educational institutions, professional associations, corporations, developmental projects, and the civic domain.¹⁵ Indeed, anywhere that practitioners can “take collective responsibility for managing the knowledge they need, recognizing that, given the proper structure, they are in the best position to do this.”¹⁶

Communities of Practice in Data Science and Library and Information Science

Previous studies on CoPs in library science have focused on such issues as reskilling library staff for new technologies, mentoring librarians toward promotion and tenure, developing teaching skills, developing emotional intelligence, and growing managerial skills.¹⁷ These studies each identify professional development areas and highlight the value of engaging in professional development through learning communities.

The field of data science is significantly younger than library and information science and was only recognized as a) a discipline discrete from computer science and information science and b) a topic worthy of study outside of statistics and data analysis in the late 1990s.¹⁸ Thus, the research on communities of practice in this area has some crossover with these related disciplines and topics.

Nischal Shrestha, Titus Barik, and Chris Parnin pointed out that data scientists are continually looking for ways to grow and hone their skillset, as topics such as data visualization constantly evolve.¹⁹ They suggested that an online community of practice designed to build expertise is important to advance work in data science and build an inclusive and welcoming community. Their research on a CoP grounded in Twitter hashtags (#TidyTuesday) found that low barriers to entry, opportunity for asynchronous



interaction, shared access to curated datasets, and an established weekly rhythm were positive enabling factors for their studied CoP. Outcomes cited from participation in the CoP included improved technical and communication skills, increased connection with members of the community and a sense of “giving-back” to the community.²⁰ In their study on the GitHub Research Data Management Librarian Academy (RDMLA), Ashley Thomas and Elaine Martin likewise highlighted the value of Twitter as a space for the formation of CoPs informally and also noted the increased value of more intentionally developed CoPs through the use of learning communities.²¹

In studying learning communities, Aparajita Jaiswal, Alejandra Magana, Joseph Lyon, Ellen Gundlach, and Mark Ward examined building a CoP for DS students employing a “quality of experience” approach that included participants rating their overall experience, connection with mentors, and satisfaction with the project. This study noted that CoP participants valued mentor relationships, that CoPs which center on learning experiences should be well structured and supportive for the participants, and that student technical skills can play a key role in their overall experience.²²

Evaluating Communities of Practice

In evaluating CoPs, there are multiple approaches, leveraging qualitative, quantitative, and mixed methods. Quite often CoPs are evaluated using a satisfaction framework.²³ In other cases, CoPs are evaluated by assessing the elements or instructional content that are included.²⁴ Some studies examine both content and satisfaction using mixed-methods techniques such as qualitative content analysis, quantitative satisfaction ratings, or correlation analysis of satisfaction scores with qualitative observations.²⁵

Across these studies, it is common for CoP assessment to focus on some sort of demonstration of value to participants. Wenger, Trayner, and de Laat discuss the notion of value in CoPs through the concept of the value creation framework (VCF), which they define as “the value that networks or communities create when they are used for social learning activities such as sharing information, tips and documents, learning from each other’s experience, helping each other with challenges, creating knowledge together, keeping up with the field, stimulating change, and offering new types of professional development opportunities.”²⁶

Wenger, Trayner, and de Laat formalize the VCF by linking activities to desired outcomes using qualitative and quantitative data about activities and multiple sources of data to support triangulation of findings. The VCF model is grounded in the idea that learning occurs in context of an individual’s engagement with two narratives: a ground narrative which speaks to the “formative events that have shaped a community or network” and an aspirational narrative which describes the CoP in “terms of the value they are expected to produce.”²⁷ They discuss the iteration between these two narratives as the space where learning happens and go on to propose the assessment of learning occurring using five thematic cycles:

1. Immediate value: Activities and interactions
2. Potential value: Knowledge capital
3. Applied value: Changes in practice
4. Realized value: Performance improvement
5. Reframing value: Redefining success²⁸

Moreover, in their foundational work on the VCF, they describe an extended categorization and coding framework for each cycle which describes indicators that may be perceived and potential data sources. This work also describes the concept of value creation stories, which are stories that help the researcher study value creation across the different cycles to understand the path of learning and value creation, for example moving from an immediate value to a potential value and, ultimately, a reframing value.²⁹ Later work on the VCF labeled the fifth and final cycle as “transformative value” and went on to stress the importance of iterative “learning loops” between the thematic cycles, illustrated in Figure 1, that provide feedback to community members about how what was learned in the CoP worked or did not work in individual practice, thus creating further opportunities for social learning and value creation.³⁰

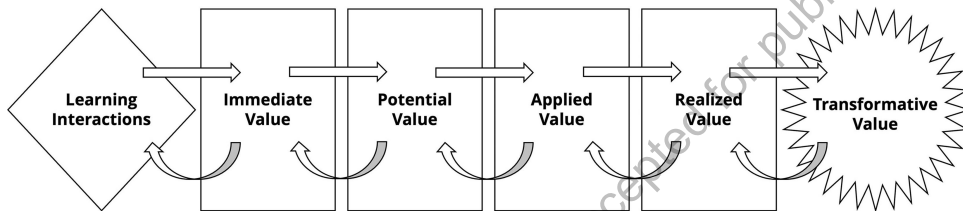


Figure 1. The iterative learning loops between the five types of value of the value creation framework.

It should be noted that the VCF has been applied in many different research environments, but the authors were unable to find examples of use in the library, information, or data science domains. For instance, Rachael Bertram, Diane Culver, and Wade Gilbert employed the VCF to study how coaches in athletics create value, and their study employed an interview data-gathering approach and qualitative data analysis.³¹ Another study employed an adapted version of the VCF in examining a teacher network based on semi-structured interviews.³² From these disparate examples, it was clear that the VCF could be successfully implemented in the study of CoPs across a variety of disciplines and, in selecting it for use in the current study, the authors noted that it allows nuanced and specific analysis of CoP interactions through a focus on individual value creation stories, helping researchers better identify and understand the outcome and impact of CoP activities and dynamics. For this reason, it was deemed an appropriate tool for assessing the perceived value of the LEADS and LEADING programs and CoP, which would help to address this study’s research questions.

Methodology

Research Design

This study utilized a sequential mixed methods design to examine participants’ engagement with and their perceived value of a fellowship program and CoP created to build DS expertise in the LIS field. The research study took place in two sequential phases,

which were conducted in November 2021 and April to May 2022, respectively. The primary means of data collection in the first phase was a mixed methods online survey (see Appendix A), and the primary means of data collection in the second phase were semi-structured interviews (see Appendix B).

Study Population and Participant Recruitment

The study population consisted of all current and former participants in the LEADS and LEADING programs, including fellows, mentors, faculty, principal investigators, advisory board members, and task force members (n=103). During recruitment, potential study participants were invited via email. One introductory email with a link to the web-based survey was sent to each of the potential participants. Follow-up reminder emails were sent one and two weeks later. Recruitment and data collection via the survey closed after three weeks.

The final question on the survey asked participants if they would be willing to participate in a follow-up interview on their experiences in the CoP. Potential participants for the interview component of the study were recruited from those who expressed interest during the survey.

Survey Design

The survey consisted of three segments, which focused on the participants' 1) value creation stories; 2) experience with diversity, equity, and inclusion (DEI) in the LEADS and LEADING program(s); and 3) demographic information. The open-ended, qualitative questions in the value creation stories section were adapted from the worksheet templates provided in the appendices of Wenger, Trayner, and de Laat's original article on their CoP assessment framework.³³ Additional questions in this section were designed to reveal what types of activities participants would like to see offered in the CoP in the future and what outputs had been produced from fellowship projects.

In the DEI section (questions 12-13), participants were provided a matrix table question aimed at measuring the level of participants' agreement with nine statements about aspects of their LEADS and LEADING experience relevant to diversity, equity, and inclusion. The first three statements dealt with diversity, the next three with inclusion, and the final three with equity. Participants were asked to rate their agreement or disagreement with each statement on a 4-point Likert scale. These statements were adapted from those suggested by Milan Fatoric in his article on asking DEI-related survey questions in the workplace.³⁴ An open-ended question also allowed participants to provide any additional information about their experiences with DEI in the LEADS and LEADING program(s) that was not covered in the matrix question.

In the demographics section, participants were asked about their age, gender identity, race or ethnicity, sexual orientation, disability status, educational attainment, current professional position, and any DS or LIS training received prior to participating in LEADS or LEADING. The questions dealing with gender identity and sexual orientation were taken from the Human Rights Campaign Foundation and the Vanderbilt University Lesbian, Gay, Bisexual, Transgender, Queer, and Intersex Life cultural center recommendations for collecting inclusive gender data in surveys.³⁵ Wording for the question about participants' race or ethnicity was adapted from the language proposed for the 2020 Census Questionnaire.³⁶

Data Collection and Analysis Procedures

The mixed methods survey was administered using Qualtrics and, following data collection, the quantitative data were analyzed using the Statistical Product and Service Solutions (SPSS) statistics software platform. The closed-ended and matrix questions were quantified using frequency analysis. Then, regression analysis was used to estimate the relationship between participants' demographic groups and the level of agreement with which they rated statements about DEI in the LEADS and LEADING programs.

The primary means of data collection in the second phase were semi-structured interviews lasting 45-60 minutes. While there was a predetermined set of questions for the interviews, these questions were open-ended and asked in a flexible way; they were used as a discussion guide, and the interviews were intended to be fairly conversational. Interviews were conducted and recorded via Zoom, and the recordings were transcribed using the transcription service Rev.com.

Following data collection, an inductive process was used to analyze the open-ended survey questions and interview transcripts, using the MAXQDA software platform.³⁷ A priori codes were derived from the five indicators of the VCF with an additional DEI code. Using these a priori codes as an overarching framework, the analysis focused on identifying emergent codes and extracting categories and themes from the data.³⁸ Each participant was considered a case, and the authors conducted a within-case thematic analysis for each participant's survey and interview, and a cross-case analysis to compare similarities and differences in the coded data and discover what abstractions could be built across cases.³⁹

Ultimately, the authors conducted two cycles of coding on each case. The first cycle coding methods used were a combination of descriptive coding, which aligned with the a priori codes, and in vivo coding, which centers the participants' voices and enhances understanding of their viewpoints.⁴⁰ The second cycle coding method used was pattern coding, where the descriptive and in vivo codes were grouped into fairly broad categories and then by narrower themes to reduce the complexity of the data to a manageable and understandable level.⁴¹

Intercoder and Intracoder Reliability

Throughout the coding cycles, several measures were taken to ensure intercoder (between-coder) and intracoder (within-coder) reliability.⁴² At first glance, this type of reliability might appear to be simply a property between or within coders; however, "the primary aim of inter- or intracoder reliability checks is to test the reliability of the coding protocol, and the protocol's ability to result in consistent categorization of content."⁴³ This consistent categorization ideally allows investigators to produce codes that lend themselves well to developing larger concepts and theories.⁴⁴

Establishing intercoder reliability involves the authors first coding independently and then discussing the results, which occurred several times throughout the coding process for this study. Together, the authors decided which of the codes would produce the most fruitful analysis of the data, and which codes should be merged, refined, or abandoned.⁴⁵ During this iterative coding and code-reviewing process, the authors also created a codebook and defined each code for the purposes of improving the intercoder reliability of further coding.

Intracoder reliability is concerned with maintaining an investigator's coding consistency across time.⁴⁶ Indeed, Stephen Lacy, Brendan Watson, Daniel Riffe, and Jennette Lovejoy claimed that the "only way to establish that the coding remains reliable is to check it at more than one point in time."⁴⁷ They further noted that reliability is less likely to deteriorate if an investigator engages in coding regularly, which, in their estimation, means coding at least every other day. That said, even regular coding would demand a reliability check if the coding process took more than two months, as it did for this study.⁴⁸ Carla Moore, Tiffany Williams, Alison Berg, and Carrie Durward also suggested that having an investigator review or re-code some or all of the data would also help establish intracoder reliability.⁴⁹ In establishing the codebook for this study, the authors reviewed and re-coded the data for the qualitative survey responses three times. For the ten interview transcripts, two were randomly selected for re-coding. In a comparison of the original and re-coded versions of these two transcripts, there was 90 percent and 93 percent agreement in the assigned codes, respectively. Using these measures, the authors found that their coding had remained consistent over time, and that both inter- and intracoder reliability had been established for data analysis.

Findings

Data analysis revealed a number of findings related to the application of the value creation framework to a DS or LIS setting, as well as additional findings unrelated to the VCF that emerged from the data collected from the survey and the interviews.

The total LEADS and LEADING program population is 103 individuals, all of whom were invited to participate in the study. A total of 54 surveys were completed, for a 52.4 percent response rate.⁵⁰ Within those 54 responses, 19 people indicated an interest in participating in a follow-up interview, and ten of those people participated in a semi-structured interview.

Applying the Value Creation Framework

While the survey was designed to capture value creation stories, exactly how to apply the VCF to the coding process was less clear. The authors developed a codebook during this process that may be of use to other researchers who wish to apply the VCF to their own work.

The authors began coding the qualitative responses to the survey and used a priori codes derived from the five value indicators in the VCF as well as a code for DEI.⁵¹ However, the authors found that these codes needed more nuance to truly capture the depth of experience expressed by survey participants. Thus, in vivo subcodes emerged directly from the survey responses, allowing the authors to center the participants' viewpoints.

Table 1 provides the codes, subcodes, and their definitions as developed for the codebook. In the codebook, the definitions for the a priori codes—except those for DEI—came from the VCF.⁵² The DEI definitions were modified from those developed by the University of Iowa.⁵³ The authors created all other definitions. The frequency of each code and subcode is also included and will be discussed in the findings.

Table 1.
Qualitative codebook and code frequency.

Codes	Subcodes	Definition	Code Frequency
Immediate Value		Immediate Value indicates that the activities and interactions between CoP members have value in and of themselves	0
	Kudos	Participant complimented the LEADS/LEADING program, curriculum, faculty or staff	21
	Suggestions for improvement	Participant suggested changes that might have improved their LEADS/LEADING experience, or suggested changes that might improve the experience of current/future participants	52
Potential Value	Learning from others	Participant described an experience of social learning in presenting outputs at LEADS/LEADING meetings and receiving feedback <i>Note:</i> This code addresses the value of interactions, hub check-ins; feedback provided that helps an individual rethink their approach	69
		Potential Value indicates that the value of activities and interactions coded under Immediate Value may not be realized immediately, but rather be saved up as knowledge capital whose value is in its potential to be realized later	0
	Technical skills	Participant learned about different data science tools and began to develop new technical skills	37
	Analytical skills	Participant learned problem solving and/or problem analysis	11
	Soft skills	Participant described improvement in their confidence, abilities as a collaborator, and/or understanding of team dynamics	16



Expanding professional network	Participant described growth in their professional and/or social/friendship contacts	45
Impact on research practice	Participant described non-specific plans for future publication/presentation of research	18
Applied Value	Knowledge capital may or may not be put into use. Leveraging capital requires adapting and applying it to a specific situation	0
Application of new skills to fellowship project	Participant applied new skills gained from boot camp to their fellowship project, building further technical expertise.	0
Realized Value	<i>Note:</i> Application within fellowship project is under Applied Value, outside of fellowship project is Realized Value	9
	Even applied new practices or tools are not enough. A change in practice does not necessarily lead to improved performance, so it is important to find out what effects the application of knowledge capital is having on the achievement of what matters to stakeholders	0
Impact on work practice	Participant described applying their learned skill in a work setting	20
Impact on research practice	Participant described how LEADS/LEADING impacted their research practice. For example, their dissertation topic changed/solidified; the program created opportunities for new/ongoing research collaborations; they have specific plans to present/publish research outputs; or they have already presented/published research outputs	30
Impact on project site location	Participant described how LEADS/LEADING impacted operations at the project site, including how the project site might approach an issue in the future or an impact on how a mentor approaches work	5

Table 1, continued.

Codes	Subcodes	Definition	Code Frequency
Transformative Value		Transformative Value happens when learning causes a reconsideration of how success is defined. It includes reframing strategies, goals and values	0
	Impact on career trajectory / goals	Participant described how LEADS/LEADING lead to career advancement, new job opportunities, or a refined vision of their career path	7
	Transformative impact on profession, program, project site	Participant described how LEADS/LEADING impacted the profession in some way, increased the number of people who are participating in the CoP, or a transformational change in how the project site operates	6
DEI	Diversity	Diversity refers to all aspects of human difference, social identities, and social group differences	4
	Equity	Equity refers to fair and just practices and policies that ensure all community members can thrive	7
	Inclusion	Inclusion refers to a community where all members are and feel respected, have a sense of belonging, and are able to participate and achieve to their potential	2
			3

This mss. is peer reviewed, copyedited, and accepted for publication, portal 24.4.



Participant Demographics and Confidentiality

Participant Demographics

For the LEADING program, graduate students in DS and LIS as well as early- and mid-career professionals were invited to apply for fellowships, which could mean that the average age for fellows may be higher than if only students had been eligible to apply.⁵⁴ Of those who responded to the survey, the average age of fellows was 38.2, while the average age of those serving in non-fellow or multiple roles was 48.5. In terms of education, 61.2 percent of respondents held a master's degree, 27.8 percent held a doctorate, 5.5 percent held a bachelor's degree, and another 5.5 percent declined to answer the question. For questions about gender, sexual orientation, and race or ethnicity, participants were allowed to choose all categories with which they identified and were allowed to skip or decline to answer (DTA) any question. Figures 2-4 illustrate the demographic makeup of the study population, with 48.3 percent identifying as women, 50 percent identifying as straight, and 60.7 percent identifying as white.

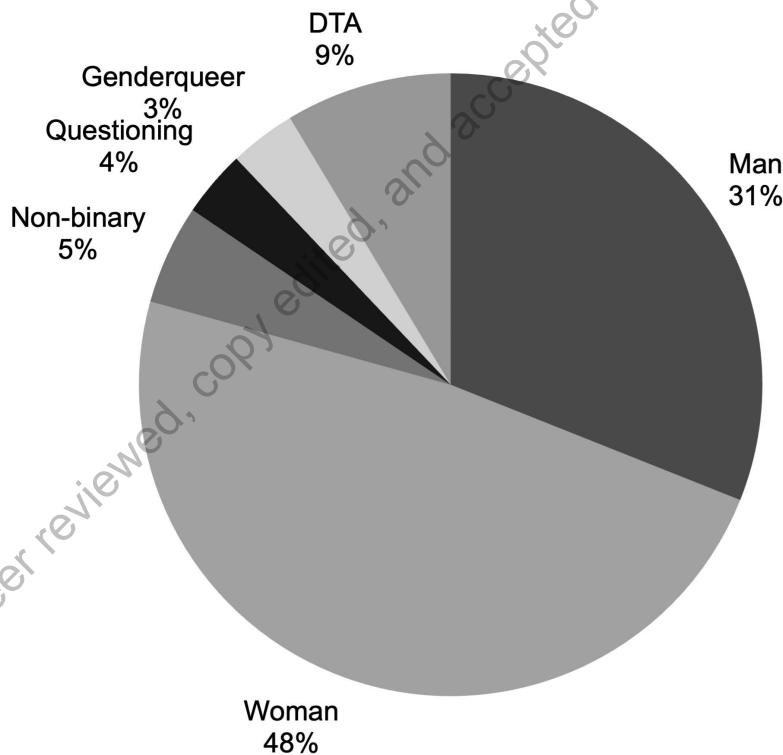


Figure 2. Participants' reported gender identity.

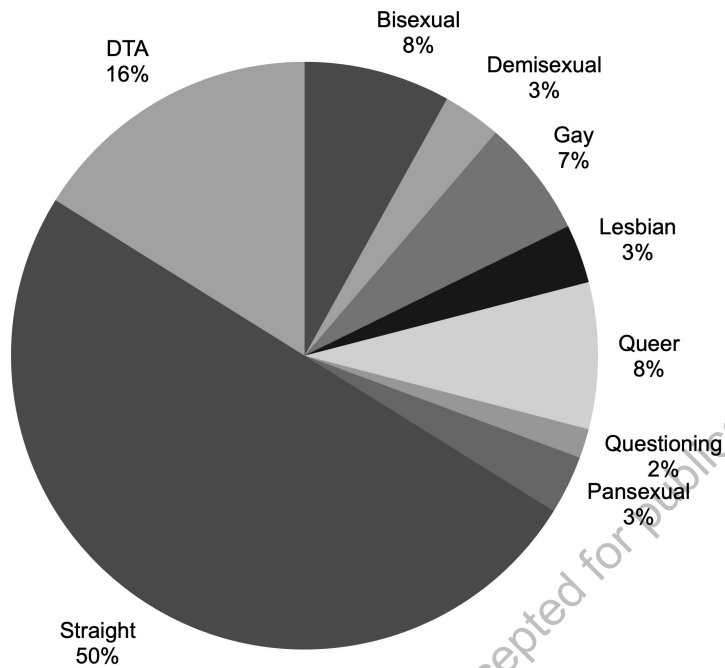


Figure 3. Participants' reported sexual orientation.

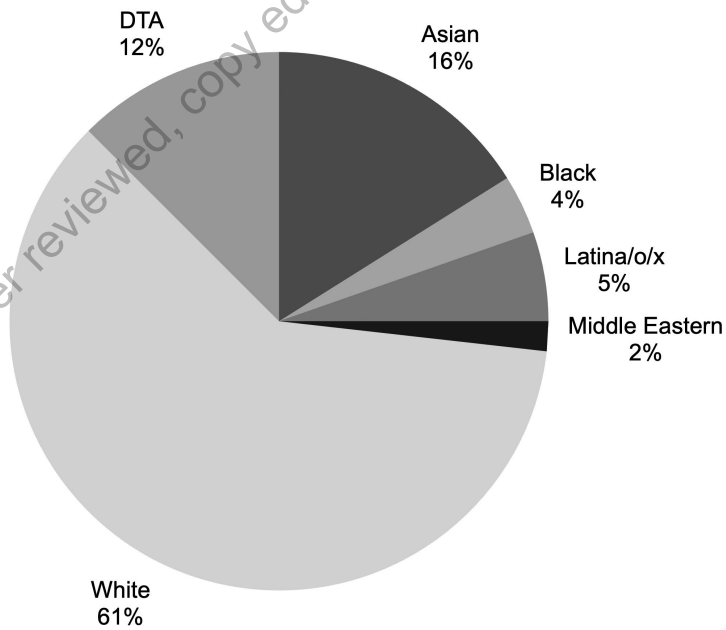


Figure 4. Participants' reported race or ethnicity.



Participant Confidentiality

To maintain confidentiality, pseudonyms were assigned to respondents, 29 of whom are quoted directly in the study findings or discussion sections (see Appendix C).

Themes Aligned with the Codebook

The majority of the findings align with the types of value identified in the VCF and described in the previously discussed codebook, but, while writing up their initial findings, the authors also identified several cross-cutting themes that did not neatly fit within the VCF. Therefore, this section will cover themes that are aligned with the established codebook and the next will look at the cross-cutting themes.

It is worth noting that, while the survey employed mixed methods, the vast majority of data collected was qualitative in nature and revolved around gathering value creation stories through open-ended survey questions as well as semi-structured interviews. The more limited quantitative data from the survey looked at CoP members' experience with diversity, equity, and inclusion in the LEADS and LEADING programs as well as their demographic indicators.

Diversity, Equity, and Inclusion

In analyzing the DEI-related quantitative data, the authors ran multiple regression models using the mean scores from the DEI matrix questions as dependent variables and the demographic indicators as independent variables, but no statistically significant results were found at the 95 percent confidence interval or above. Even when the data gathered from the DEI matrix question was viewed as a single scale versus three separate subscales—one for diversity, equity, and inclusion, respectively—no statistically significant results were found. Out of 4 points, the mean score for diversity was 3.65, for equity 3.46, for inclusion 3.47, and the full DEI scale received a mean score of 3.53. The authors found that there were no demographic groups or subgroups that rated the LEADS or LEADING program higher or lower based on diversity, equity, and inclusion, indicating that most of the respondents rated the program fairly well with regard to DEI. Indeed, the responses from the open-ended survey question about DEI (question 13) and DEI-related comments from interview transcripts also indicated generally positive experiences. It should be noted, however, that these comments were relatively infrequent, making up only 4.42 percent of the overall number of codes assigned during the coding process (see Table 1).

Parker, a LEADS fellow and LEADING faculty member, stated that “it is clear that the LEADS/LEADING team increasingly puts time and effort into ensuring diversity, equity, and inclusion in the program, and always strives to improve,” concluding that “the diversity of LEADS/LEADING is one of its greatest strengths.” Along the same lines, Nora, a LEADING fellow claimed, “I think I really was impressed with the cohort we had because we were a diverse group of people, not only backgrounds and our current professional work and where we were physically located, where we were from. So, that was really nice to see. It’s not often that you’re in a committee or organization where it’s just different faces, different people, different ages. So, I think that made this experience even more valuable.”

Torsten, a mentor and primary investigator (PI) on the LEADING grant, said that DEI “has been an area where the LEADING project grew considerably in the past year.” He went on to say that “more work is needed to build a diverse cohort of fellows in each iteration and to encourage host institutions to consider DEI in their selection of projects [and] interactions with fellows.” A suggestion from one of the LEADING faculty, Wade, on how to consider DEI in project selection was that “it would be great if a mechanism could exist for some fellow(s) to self-identify projects, and identify their own stakeholders,” noting that “this would certainly engage diversity and inclusion, and could afford for program expansion opportunities!”

Interestingly, one of the only significant findings that arose from the multiple regression analysis was when the authors looked at participants’ roles in LEADS and LEADING and found that mentors tended to rate the program lower across the board and discussed fewer positive experiences overall in the open-ended survey questions and interviews.

However, one of the mentors, Sofia, who had co-mentored two fellows with another librarian, was less enthusiastic. She said, “both of our fellows were women of color [and we’re both white], so there was also this awkward thing...for white people of varying ages mentoring two young women of color. So, those were really interesting power dynamics.” Interestingly, one of the only significant findings that arose from the multiple regression analysis was when the authors looked

at participants’ roles in LEADS and LEADING and found that mentors tended to rate the program lower across the board and discussed fewer positive experiences overall in the open-ended survey questions and interviews.

Immediate Value

When assessing immediate value, many participants spoke to specific interactions that they felt contributed to their experience in LEADS or LEADING. Dozens of survey responses offered “kudos” and named individual LEADS or LEADING staff, faculty, and mentors for providing clear communication about the program, offering guidance,

and assisting in their learning process. Indeed, the immediate value subcodes were the most frequently applied during coding, representing 39.23 percent of the total codes (see Table 1).

One type of interaction from which participants obtained immediate value was the data science boot camp offered directly prior to the start of fellowship projects each year.

One type of interaction from which participants obtained immediate value was the data science boot camp offered directly prior to the start of fellowship projects each year. The boot camp was offered in person on the Drexel University campus prior to the COVID-19 pandemic and has been offered online since then. Not only did formalized learning take

place between faculty and fellows, but also community-building and social learning among fellows.

One LEADS fellow, David, discussed the varied ways that boot camp provided immediate value when he said, “The boot camp established a sense of community among fellows, taught me some data science skills, and helped me get to know some of the Drexel faculty personally.” Tying together boot camp and the larger program, Parker noted, “While the boot camp is immensely useful by itself, the real strength of the LEADS/LEADING program is that the fellowship experience works to embed those skills through an immersive, hands-on internship with a remote institution. That hands-on experience is invaluable for professional growth and development.”

Other participants also pointed to group check-ins throughout the fellowship which allowed them to touch base with other people and learn about ongoing projects. This provided immediate value in the form of social learning. For example, one fellow, Frances, said that “[Another fellow] did some really cool audio transcription stuff and built a Streamlet. I built a Streamlet. So, I looked at hers like, ‘oh, that’s a cool thing I didn’t do.’ We can still learn a lot from each other.” One of the mentors, Harper, echoed how valuable these check-ins were, noting that they “enjoyed hearing about the variety of projects and types of work and learning happening.” And, looking beyond the fellowship into the developing CoP, another mentor, Luc, said, “as we grow and we develop a network of support and, maybe on my next research project, if I’m not sure of the method, I could have a community to go to and say, ‘Someone help with this.’ Just maybe open research practices to level the playing field. And to know that community and an ability to communicate easily with that community.”

Immediate value focuses on engagement and learning that happen “in the moment,” but that learning can—and often does—easily segue into the category of potential value, where participants anticipate the future value in what they have learned.

Potential Value

While potential value was an a priori code that arose from the framework, the in vivo codes that emerged during data analysis were quite varied for potential value, including technical skills, analytical skills, soft skills, expanding professional network, and impact on research practice. These codes were only slightly less frequent than those under immediate value, making up 37.57 percent of the overall codes (see Table 1).

For the impact on research practice, potential value is differentiated from realized value by the *possibility* of future dissemination of research in the form of presentations or publications. Often this referred to in-progress work or to non-specific plans for research outputs. One fellow, Ash, noted that the experience provided her with “a greater toolbox of skills to use in existing projects and whenever working on future projects, [plus] more publications to work on.” A mentor, Sarah, said, “I feel like I made a few great connections that I hope will last longer after the program and that we will collaborate on future research projects, presentations, and articles.” Sarah’s comment also encompasses the idea that, not only did the fellowship program provide possibilities for research collaborations, but also interpersonal connections that expanded participants’ social and professional networks.

One LEADS fellow, Colleen, pointed out that the program “allowed me to connect to a network of people working on projects that I am interested in,” and a LEADING fellow, Ji-an, noted that this trend continued into the newer iteration of the program, saying, “To me, networking is key! I am planning to apply all the knowledge / skills that I learned to other similar projects in my own library and contact mentors and peers to do additional collaborative work.” Jordan, another LEADS fellow, said that the program “gave me a cohort. We get so siloed, even in our field, that I wouldn’t have met these people or heard about their projects...I made friends in this program.” Another LEADS fellow, Kay, went into greater detail on the matter,

I think probably the most objectively valuable part was connecting with my fellows, seeing them, we met in person for the boot camp part. And then I got to see people at conferences and go, ‘Oh, I know that person.’ And have someone to hang out with or to just be familiar with what they’re working on. I did a few things like that during my grad school career and I think that was the best move that I made overall...But largely, just a really nice, just pre-made network if I go into a conference that I may not know anyone at.

Beyond the “pre-made network,” several respondents also noted the sense of community they felt after their participation in the program. For example, Jordan said that “they helped me develop a community based in using data science for positive ends.”

The interpersonal and professional network growth mentioned by participants led naturally into a discussion of ways in which their LEADS or LEADING experience impacted the growth of soft skills, which are skills related to leadership, team building, collaboration, communication, critical thinking, problem solving, and emotional intelligence.⁵⁵ Interestingly, this was an area where several mentors noted skill growth.

The interpersonal and professional network growth mentioned by participants led naturally into a discussion of ways in which their LEADS or LEADING experience impacted the growth of soft skills, which are skills related to leadership, team building, collaboration, communication, critical thinking, problem solving, and emotional intelligence.

Peter saw ways that he had helped grow the confidence of his fellows by creating a safe space for experimentation, noting that “I think I was able to support the fellows as they took risks while adopting new technology, giving them a safety net so they could confidently explore and ask questions.” On the other hand, Brooke noticed how her role was to serve as a link between the fellow and the host organization, saying, “from my experience, I contributed perspective on the significance of the LEADS project to the user community we served. I also facilitated connections and networking to others in the community, outside of the host organization,

that could inform the project.” From the fellow perspective, Ari noted that “I learned technical skills directly related to my fellowship site, as well as collaboration skills” and that the experience “helped with confidence in problem solving.”



Another natural transition in the way participants discussed their experience was a shift from the soft skills of critical thinking and problem solving to the analytical skills required for data science projects. Parker stated that “this experience has taught me many things, including how to independently problem-solve when it comes to data science, and how to develop creative solutions to information science challenges.” Gayatri, a LEADING fellow, said that she “learned a lot about the peculiarities of planning a data science research/explorative project and the need to remain flexible and open throughout.” Another fellow, Dieter, said that the program “enables us to learn and use our data science skills in a real-world application.”

In terms of real-world applications, many fellows delved into technical skills they had learned in the program and often named specific tools and technologies they had used for their fellowship projects, which might be of potential use in future for their work as librarians or data scientists. Indeed, a LEADS fellow, Colleen, mentioned that “I learned and am still learning about the possibilities for data exploration in library settings.” Jordan compared their pre- and post-LEADS skills, saying, “I came in with very basic skills and learned to locate tools for data analysis and manipulation. I ended up using OpenRefine for most of my project.” Conversely, Tate “was able to get exposure to a number of tools I have seen used in other projects and settings—e.g., Jupyter notebook, Apache Spark, John Snow Labs’ Natural Language Parser” and he went on to say that “my LEADS experience afforded me some foundational knowledge to better orient myself with specialized tools I may not otherwise use in my research. This has been helpful in situating my perspective and providing a frame of reference to orient myself when entering new research projects.” Python was the most common tool noted by fellows, including Peter, who said, “I learned more about graph network analysis and the use of NetworkX in Python. I also learned a lot more about entity resolution techniques in Pandas.”

With the many tools and technologies mentioned by fellows, there was a significant crossover in terms of technical skills between potential value and realized value. As demonstrated above, many noted that they had learned to use a variety of tools, some of which were of potential value and some of which were used in their fellowship projects or their professional work, which shifts those skills from the category of potential to realized value.

Realized Value

Participants described realized value in a number of ways; notably, in the impact the fellowship project had on the project site and in the impact the CoP has had on their professional and research practice. These were the third-most frequently applied codes during the coding process, at 15.19 percent of the total codes.

In terms of realized value for project sites, in many cases the mentors pointed to how important it was to have a fellow who could dedicate time and attention to a project that the site might otherwise not have been able to devote the resources to completing.

In terms of realized value for project sites, in many cases the mentors pointed to how important it was to have a fellow who could dedicate time and attention to a project that the site might otherwise not have been able to devote the resources to completing. In this case, Dieter appreciated having a clear goal, noting that the fellowship project's "limited-time also encouraged us [his mentor and him] to perform and focus on the product that we can deliver" within the timeframe. Other sites lacked the data science expertise to even approach the project they hoped the fellow could work on, which, at times, resulted in frustration for the fellow. For example, another fellow, Blake, said, "I think I would have benefited from a mentor to work through the coding aspects with, but my mentor does not code in Python or know how to do machine learning, so I was left to learn it all myself, which I could not do. My project won't be finished, but I feel like I could have finished it if I had had sufficient support."

Heidi, a LEADS fellow, said, "I did not have sufficient technical skills to make much progress on my particular project (which was quite broad)," but went on to say that "I very much enjoyed getting to know and working with my mentor. It was also great to spend time with other fellows as a cohort at the boot camp and follow up meetings" and so the program was rewarding. Heidi is now a faculty member at an LIS school where she is "pleased to be in a position to funnel new students into LEADING." This type of narrative became quite common in responses from fellows who were unable to complete their project to the level they might have hoped—they still found the experience valuable, would recommend the program to others, and still actively engage in the CoP even after their one-year commitment to the program has finished.

For those who experienced realized value as part of their research and professional practice, many discussed ways in which they have employed the skills they have learned as members of the LEADS and LEADING community. For example, Nora stated, "Professionally, I am able to carry over my new technical and research skills and apply them directly in my career." David observed impacts on both professional and research practice, saying that the LEADS "data-intensive project resulted in a best paper award at ASIS&T [the Association for Information Science & Technology Annual Meeting]. I think that my experimental design and data analysis in that paper were stronger because of LEADS. Even more important to me, I taught a data science class that was very programming intensive the year after LEADS. I think that I would have been lost without the background knowledge on data cleaning that I got from LEADS."

Indeed, when discussing realized value regarding research practice, many respondents cited publications and presentations—either completed or in-progress—that had resulted from their participation in LEADS or LEADING. Several also noted ongoing research collaborations that had come from connections made with other CoP members, during or after their time as a fellow or mentor. For instance, Nora said, "this experience gave me a chance to co-author and publish a conference proceeding. Next month, I will participate in a virtual workshop to present our findings. I have never conducted this level of research and found the experience to be valuable and rewarding. I had 2 mentors who co-authored the paper with myself and my partner. I could not have written the paper without their guidance."



Transformative Value

Several notable themes emerged in participant responses regarding transformative value, including transformation to the fellow's educational or career trajectory and impact to the LIS or DS profession, program, or project site. These codes were the least frequent, representing only 3.59 percent of the overall number of codes assigned.

A few fellows found that the skills they had developed working on their project impacted their dissertation, either by changing their research topic or providing them with new analytical tools with which to approach their research. For example, Parker claimed, "the LEADS program has also directly helped me to refine my research interests and shape my dissertation, which builds upon my LEADS fellowship research." Heidi stated that "while my LEADS project was unrelated to my dissertation, through trial and error I acquired skills that were very useful for my own eventual data challenges." She went on to point out the ways her fellowship influenced her career trajectory and marketability, saying "I also believe this fellowship strengthened my job applications and in part led to being selected for a tenure track faculty position in LIS."

Other fellows expressed similar changes to their career outlook after the program. Nora said, "I have used my improved Python skills already to work with metadata at the institution where I work. Personally, I have a strong sense of achievement from this experience. I also like how these new skills can be added to my resume, and I will be 'seen' as a more valuable candidate for other roles/jobs."

Gayatri noted that her new knowledge would change her approach to current work, and to her career path, stating that "I gained knowledge and experience with certain data science tools and techniques around transforming and enhancing digital collections (in the academic library setting). This experience has put me on the path to pursue professional roles with similar focus." However, there are those who came out of the experience with new knowledge of what career path they do not wish to take; for instance, Blake said, "I mostly discovered that I do not want to pursue data science in the future."

Other participants mentioned the wider impact of the LEADS and LEADING programs, to institutions or the profession. In terms of institutions, several mentors noted that the fellows impacted the project site. Indeed, Lisa said, "Our fellow had the opportunity to contribute real expertise and research to a major project at my institution... My LEADING fellow helped us to develop a practice for managing our Name Authority in Wikidata. By the end of the program, he was more the mentor, leading mentees through this new-to-us environment... Quantitatively, we now have over 9,000 records in Wikidata and 3 staff have training in using Wikidata and OpenRefine. We will be applying lessons learned to another project." Similarly, Oscar said the result of two fellowship projects on his site meant they were "trending toward [the] development of a template approach to refactoring dated digital collections."

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In terms of broader impacts, Luc said, "I think our collective experience has contributed to info sharing, support, and communication across important research projects relative to librarianship and data science. The growth of this professional community is important to the field." Heidi concluded that "this is just a fantastic initiative and should continue permanently to transform LIS and empower libraries."

Cross-Cutting Themes

Three additional themes emerged from the analysis of responses and the application of the VCF which did not directly relate to the constructs of the VCF: connectedness, emotional engagement, and demonstrated community values. In considering these themes, the authors found that they overlaid or, perhaps more accurately, cut across the VCF constructs, and that each of the three emergent themes has a strong connection to Social Cognitive Theory; although, the authors note that, given the introspective nature of the survey questions, it is likely that any personal or social theoretical framework would fit. However, Albert Bandura's concepts of self-efficacy and social learning stand out, in part, because the primary trigger for participation in this CoP is an expressed interest in building or extending proficiency in a skill-related area. Moreover, self-efficacy aligns well with the study framework of assessing different forms of value because self-efficacy is the expression of whether or not an individual has the capacity to engage in an activity (potential value), not just whether or not they did (realized value).⁵⁶

Self-efficacy is described in the literature as involving five mechanisms: mastery experiences, modeling or vicarious experiences, imagined experiences, social persuasion, and somatic or emotional cues.⁵⁷ While the LEADS/LEADING project is largely centered around creating opportunities for mastery-centered experiences (self-performance of a goal) each of the other four mechanisms are also present. For example, LEADS and LEADING used meetings, presentations, and group information sharing to develop opportunities to witness the experiences of others (modeling or vicarious) as well as the power of social connections to and encouragement from others.

Connectedness

Within the context of this study, "connectedness" relates to the extent to which the participant felt or demonstrated a sense of being actively connected to or engaged with the CoP. It is similar in many ways to the term "belonging," which includes factors such as social, emotional, ethical, political, and location-based positionality.⁵⁸ In thinking about the meaning of belonging, it proved useful to draw on Kaisa Kurne and Atte Vieno's discussion of belonging as "actively shaping social relationships and their practices" in individual, social, emotional, ethical, political, and other contexts.⁵⁹

Within this theme, respondents commented on both social and professional connectedness. For instance, Eve, a PI said, "Personally, I feel like I've made many good friends via LEADS + LEADING at all levels. Yes, they are work friends, not my neighbors, but in our connected lives, and, also, in the last 18 months, going through LEADING during a pandemic, has added a different dynamic which is important here, as we all seem to care about one another too." This example illustrates multiple common themes centered on connectedness, including interacting through online means, building professional and

social connections, and situating this experience in a broader social landscape. Many other responses focused on specific channels for staying connected—email, regular meetings, group check-ins—and provided advice on technological and communication factors that can influence connectedness. Indeed, one LEADING fellow, Ruby, stated that the “group check-ins and social gatherings were especially meaningful during the pandemic because we didn’t have the opportunity to meet each other in person during boot camp, so these events were our best chances to connect, get to know each other, and build community within our cohort and with other mentors, faculty, and PIs.”

Some participants also referenced concepts such as confidence or a perceived increase in ability or new technical skills in concert with connectedness. Ifeoma, a LEADING fellow, said, “Both the boot camp and mentor check-ins provided a safety net in terms of knowing who I could reach out to if I needed help/clarification. The regular mentor check-ins helped me keep the focus on what the goals for this experience were and are a source of encouragement and support.” Given the social and professional network connections as well as the intersections with increased soft and technical skills, this theme cut across the VCF constructs of potential value, applied value, and realized value.

Emotional Engagement

There were many instances in participant responses where emotions were cited as a causal or supporting aspect of CoP engagement. Michelle, a mentor, said, “I tried to be an effective mentor but wasn’t given guidance on what that looked like, or how to structure fellow projects, or what would ‘contribute to the goals of the LEADING Program.’ I guess by working with fellows on their data science skills, that would be contributing?”

In pointing to the emotions that were part of her mentor experience and how a different approach to mentor support might have helped her fellow be more engaged, Michelle highlighted how her individual experience and reaction influenced her overall view of success. From another perspective, Ifeoma commented that the CoP was a positive emotional experience in part because it served as a “safety net” for engaging with data science and multiple respondents commented that aspects of emotional safety enabled participation. For instance, Peter said that, “I think I was able to support the fellows as they took risks while adopting new technology, giving them a safety net so they could confidently explore and ask questions.” The theme of emotional engagement cut across aspects of immediate value, potential value, and applied value.

Demonstrated Community Values

Unlike the values defined by the VCF, which look at aspects of LEADS and LEADING that participants found personally or professionally valuable, the final cross-cutting theme focused on shared values or principles. There were multiple instances in which participants highlighted a value that they felt was held by the entire community. These statements often included an underlying or assumed value, rather than an explicitly stated value. For example, across many responses, there was a bias toward the importance of technical innovation as well as the value of peer-based learning or coaching. To illustrate these points, Parker noted that the program “gave me the confidence to explore innovative solutions to real-world data science challenges,” while Nora, Kay, Dieter, Tate,

and Frances all gave lists of different technologies they learned to use because of LEADS and LEADING, including Python, Pandas, R, Jupyter notebooks, NetworkX, OpenRefine, Apache Spark, and John Snow Labs' Natural Language Parser. Furthermore, Wade said that "I want to highlight the impact I've seen from fellows preparing to share work and through the feedback they receive in response. We set up projects for individuals, and in some sense this defines workloads and productivity. Furthermore, mentors critically drive and guide fellows to/through work. However, these same effects appear to be strongly catalyzed and perhaps inspired to a greater degree of independence for fellows when they need to advance research to the point where it may be presented to their peers." Additionally, whether by highlighting a positive experience or calling out a need for more support, many responses were grounded in the recognition of an espoused value of "working together." Thus, the authors found that participant responses included in Demonstrated Community Value cut across all of the value constructs of the VCF.

Discussion

Observation on Use of Framework for Coding

The authors found through their data analysis that Wenger, Trayner and de Laat's coding framework for evaluating CoP elements lent itself well to informing an overall understanding of how study participants viewed the immediate, potential, realized, and transformative value of participating in the CoP.⁶⁰ While the responses were often positive, the authors found that analysis of statements that focused on potential value helped identify new interventions that could have a beneficial effect on the CoP as well as identify areas where the participants indicated a need or want related to their personal engagement with the CoP.

As just one example, Michelle's discussion about her experiences as a mentor indicate that her engagement with the CoP would be improved with more communication and guidance from program leadership. While her overall comments were positive, this suggestion provided the authors with a useful direction to consider, making use of the "immediate, realized, potential" coding framework especially valuable. The inclusion of the participant role (fellow, mentor, and so on) was especially helpful in identifying a future intervention, and the authors note from this the importance of understanding how one's position influences CoP participation and perception.

CoP Design and Participants' Sense of Success

Analysis of participant responses revealed that, in addition to factors that could influence CoP design, respondents also noted a number of factors that related to an individual's sense of success. This finding is aligned with individual success models such as Julio Garcia and Geoffrey Cohen's social psychological model for educational intervention, which explores how social cues interact with individual identity and influence an individual's participation in a learning environment.⁶¹

Garcia and Cohen discuss learning environments as "social tension systems," in which social and individual dynamics exist in a "dynamic state of interaction" (the social environment interacting with an individual's sense of self-efficacy, identity, and personal



perception of the environment) that influence achievement over time.⁶² The framing of social tension systems as an element of the CoP model helps illustrate how individual achievement and perception can be influenced through observation and intervention. In designing a potential intervention, Garcia and Cohen consider social and psychological factors and emphasize the importance of timing and targeting interventions to individuals or groups appropriately.⁶³

In context of the data collected as part of this study, participants' comments regarding perceived barriers or potential success enablers, for example sharing additional information with mentors, could be identified as possible interventions if attention is paid to how and when those interventions should be applied. These interventions are in addition to the foundational work that should be undertaken to create a CoP based on inclusion, respect, and CoP member empowerment and support. Said in a different way, the authors for this project found evidence that participants considered individual context, social context, and the CoP academic context as influential factors in their experience. This points to the need to develop individual interventions along with social and academic interventions as part of enabling a positive and sustainable CoP. Additionally, the authors believe that this work is especially important when building cross-disciplinary CoPs such as the LEADING community. This became apparent in the three cross-cutting themes that emerged for the authors: connectedness, emotional engagement, and demonstrated community values.

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Examining the Cross-Cutting Themes

In terms of connectedness, having a better understanding of how individual, social, and technical factors influence a sense of connectedness is helpful in designing future interactions and in evolving the CoP. Additionally, the evidence of "social tension systems" at play help the authors think about the multiple levels of interdependence between CoP interventions and individual support and engagement work. Considering emotional engagement, the findings reinforce the need for individual support, which can increase reports of connectedness within the community as well as a sense of safety and confidence in attempting new techniques and technologies for projects.

While the survey questions were not asked in a way that would enable a complete analysis of commonly held community values, the authors believe that understanding these underlying values will be useful in designing interventions and future study questions that could potentially surface, but not presume the presence of, shared values. Indeed, the authors note that reflecting on whether or not the CoP is living up to its espoused values would be a useful activity. Drawing on Gallagher, Garcia, and Cohen and Wenger, Trayner, and de Laat, the authors affirm the importance of establishing, highlighting, and promoting values-centered discussion as a general CoP community-building intervention.⁶⁴

Addressing the Research Questions

Two research questions guided this study, and it is important to discuss how the findings address these questions.

RQ1 called for an examination of the aspects of the LEADS and LEADING fellowship program and community of practice that participants found valuable. The responses from participants—as reported in the findings—were overwhelmingly positive, with many specific aspects of the program, such as the boot camp and support from mentors, and CoP receiving multiple mentions for adding value to participants' experiences. The two key areas where responses showed a lack of value were 1) DS technology and tool support for fellows after they completed the bootcamp and began their project, which was addressed by adding a monthly check-in for fellows with bootcamp faculty, and 2) support for mentors, which has been dealt with by including check-ins between and among mentors. Analysis of data from the second and third year of the COP will help determine whether these changes effectively resolve the concerns.

Next, RQ2 looked at the extent to which LEADS and LEADING participants believe that the program is inclusive, equitable, and diverse. The mean scores for the DEI subscales and full scale were high, at 3.46 out of 4 or above, and, overall, there was no indication that demographic indicators such as educational attainment, gender identity, sexual orientation, (dis)ability, race or ethnicity had any significant impact on participants' reporting of positive or negative experiences in the fellowship program or CoP.

Instead, the role that the participant played in the LEADS and LEADING program had an unexpectedly significant impact, with the mentors' experience arising as a theme in both the qualitative and quantitative data analysis. Mentors rated the diversity and equity subscales as well as the full DEI scale, lower than participants in any other LEADS or LEADING role. While there is no clear reason why these subscales were scored lower, the overall findings would indicate that mentors felt less supported in the program and less connected to the CoP than those in other roles. Mentors also felt unprepared for some of the demands of their role. As mentioned previously, this data suggested that interventions aimed specifically at mentors might improve the experience of those filling this role in future, an area of ongoing change within the program.

Implications and Takeaways

Implications

Through this study, the authors affirmed the importance of considering expressions and perceptions of value as well as the role of individual thoughts and feelings in evaluating a CoP. The resulting three themes that emerged—connectedness, emotional engagement, and demonstrated community values—each connect back to foundational work defining the aspects of a CoP.

In discussing how to create effective CoPs, Wenger and Snyder observe that CoPs may form out of informal or formal networks but need specific support to evolve into a CoP. This support includes providing a broader organizational context for the CoP, sponsorship at an effective level to help the CoP attract members while also providing



resources and support to foster sustainability and growth, and recognizing the broader engagement and less formal processes associated with CoP.⁶⁵

In considering the value of the CoP model for skill and professional development programs such as LEADS and LEADING, the authors believe that the inclusion of a CoP model and the use of reflective practices for improvement that lead and cede control of the CoP in different ways can be a highly effective approach that results in greater learning and professional practice impact as well as more sustainable outcomes for these types of projects.

Key Takeaways

There were numerous lessons learned about designing and evaluating the LEADS and LEADING programs, but the authors can offer a few key takeaways for those considering similar projects.

First, consider the context of individuals and groups, and design social or learning inter-

ventions that will allow experimentation, a sense of safety and belonging, and success within the program or community. These interventions should be targeted and timed appropriately. In the case of this study, that meant considering how best to support mentors and creating interventions that supported individual fellows who might need technical assistance beyond the bootcamp.

Second, when evaluating the effectiveness of the interventions, consider the implicit and explicit values of the community and its members. The VCF was a useful tool in understanding what aspects of the program and CoP members found valuable but only hinted at the underlying values of the community. A more direct exploration of community values might be useful in planning appropriate interventions and making the CoP more impactful for participants.

Third, consider using the VCF as a way to explore what members find valuable about participating in the community or program. While this study used the VCF after designing the CoP to understand and improve the experience of members—and the authors found it effective for that purpose—it might also be useful to consider the value constructs in the VCF when beginning the design process for a CoP.

Limitations and Significance

There are several ways in which this study can contribute significantly to scholarship, specifically the growing professional knowledge that intersects DS and LIS. Indeed,

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given the aforementioned lack of literature on the topic of CoP evaluation in LIS and DS, this study begins to fill that gap in LIS and DS research. Next, this study adapted the Wenger, Trayner and de Laat value creation framework into a mixed method survey instrument, which could be used by researchers—be they LIS, DS, or otherwise—wishing to evaluate a community of practice using similar methodology.⁶⁶ Indeed, to the best of the authors' knowledge, the VFC has not been previously adapted to an online survey format for research purposes, making this a unique contribution to the academic discourse. Likewise, the authors did not find other published works which applied the VFC in any format to CoPs in either the LIS or DS professions, thus offering a novel approach to this topic for both disciplines.

However, there are also several limitations that must be discussed regarding this study. The majority of data analyzed came from an online survey, and there are two main limitations to online surveys. The first, this study avoided; the second, it may not have.⁶⁷ First, many online survey studies have difficulty describing the population their survey was distributed to—listservs, for example—and, therefore, do not produce a representative sample.⁶⁸ Given that this survey was distributed individually to all current and former participants in LEADS and LEADING, the population can clearly be described. However, the vast majority of respondents reported positive experiences with the fellowship program and CoP, which may indicate a selection bias, another major methodological flaw to consider with online surveys.⁶⁹ When participants opt into a survey, there may be underlying reasons for doing so, such as a positive or negative experience, which can skew the sample so that it is not representative of the overall population.⁷⁰ What this would mean is that the findings cannot be statistically generalized to the population, and that there may be an overrepresentation of those who had positive experiences in LEADS and LEADING.

That said, statistical generalizability allows researchers to draw inferences “about a population (or universe) on the basis of empirical data collected about a sample” subset of that population, but this is “not typically considered a feature or goal of qualitative research” and would not be applicable to the responses to open-ended survey questions and interview portions of this study.⁷¹ However, there are other conceptions of generalizability that would be applicable to qualitative research, such as analytic generalizability and transferability.

Analytic generalization, according to Robert Yin, is when “a previously developed theory is used as a template with which to compare the empirical results... If two or more cases are shown to support the same theory, replication may be claimed.”⁷² However, it should be noted that Yin's description has since been expanded by other qualitative researchers to more than just *previously developed* theory, since “theories in qualitative research are often inductively developed” during the analysis process.⁷³ While the current study did not develop new theories, the data revealed numerous examples of how participant cases supported both the VCF (themes aligned with the codebook) and Social Cognitive Theory (cross-cutting themes), which would suggest that replication of these theories is a reasonable claim and, therefore, that the conditions for analytic generalization had been met by this study's findings.

Transferability argues for the idea of generalization “rooted in a conception of experiential knowledge,” allowing readers to vicariously experience a different context which might enrich their current thinking about a topic.⁷⁴ Hence, gaining insight about

what perceptions LEADS and LEADING members have regarding the value of engaging in a CoP could allow others in the field to better understand their own perceptions about CoP engagement. Likewise, those in the field might deepen their awareness of using the VFC as a tool for assessing CoPs. Transferability, then, would allow those who read the study's findings to decide for themselves whether the results are transferable to their particular context.⁷⁵ From that standpoint, this study might specifically be useful to other LIS or DS professionals, giving them insight into transferable strategies to establish and evaluate a community of practice.

Conclusion

This study explored the formation of a CoP related to Data Science and Library and Information Science through a mixed methods research approach. In focusing on the LEADS and LEADING CoP, the study assessed how members joining this community from different perspectives and serving in different roles experienced and found value in participating in the CoP. The results of this research allowed the authors to:

- 1) inform the current LEADING CoP through identification of community building approaches and interventions,
- 2) develop and provide examples for a value-perception framework that could help other CoP designs, and
- 3) apply the Wenger, Trayner, and de Laat VCF model, resulting in a survey instrument and codebook that could be used in future research settings.⁷⁶

While previous research had applied the Wenger and Trayner CoP formation framework, this study took the model one step further by adapting and applying an assessment that supported a cyclical and repeatable CoP evaluation. This instrument has enabled the LEADS and LEADING CoP to consider what members have valued in the past and what they continue to value, enabling the CoP leaders to approach an iterative design process.

In using the five indicators of the VCF (immediate, potential, applied, realized, transformative) as well as DEI-centered values, the authors found clear evidence of themes that are reported in the literature as highly influential in CoP value perception, such as connectedness, emotional engagement, and community values. The authors also found that the emergent codes that were generated through the coding process helped provide added context and insight about how CoP members defined value (personal, professional, technical, social). Having a more nuanced sense of value in this way will help the authors continue to identify, implement, and evaluate interventions within the CoP.

Acknowledgement

This project was made possible in part by the Institute of Museum and Library Services (IMLS) RE-246450-OLS-20.

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Appendix A

Community of Practice Survey

The LIS Education and Data Science for the National Digital Platform (LEADS-4-NDP) and its successor LIS Education And Data Science Integrated Network Group (LEADING) aim to “prepare a diverse, nation-wide cohort of...LIS doctoral students and early to mid-career librarians for data science endeavors.” Among the program’s goals are fostering collaboration and community development to enable “a culture of mutual growth and continued sharing across the [LEADS and] LEADING network.”

With that in mind, this survey is designed to help uncover what, if anything, LEADS and LEADING fellows, mentors, faculty, and other program partners found meaningful or valuable about their experiences engaging in the program(s) or as part of this developing community of practice, what might be improved about the program / community going forward, and if the program / community is making strides towards increasing diversity, equity, and inclusion amongst its participants.

Thank you for taking a few minutes to complete this survey.

Please answer the following questions regarding your experiences with the LEADS and/or LEADING Program(s).

1. Which program(s) did you participate in? (Select all that apply.)
 - LEADS (2018 - 2019)
 - LEADING (2021 -)
2. Which role(s) have you filled in LEADS/LEADING? (Select all that apply.)
 - Fellow
 - Mentor
 - Faculty
 - PI / Co-PI
 - Advisory board member
 - Taskforce member (e.g., DEI)

(If fellow and non-fellow roles are both selected, display instruction text. If only fellow or only non-fellow roles are selected, proceed to 3)

Instruction text: You indicated that you have filled both fellow and non-fellow roles in LEADS/LEADING, so we would like you to answer the following set of questions (unless otherwise indicated) **from your perspective as a FELLOW.**

3. Which of the following activities did you find meaningful to participate in as part of LEADS/LEADING? (Select all that apply.)
 - Mentor check-ins
 - Group check-ins with faculty, PIs, and fellows
 - Opportunities to present accomplishments/ outputs
 - Boot camp
 - Social gatherings
 - Other _____



4. Why were these LEADS/LEADING activities meaningful to you?
5. Please describe what you learned from your LEADS/LEADING experience.
6. What difference(s) did this experience make in your research, professional and/or personal practice?

(If only fellow was selected in question 2, skip to 7. If fellow and/or any other role was selected, proceed to 6a.)

6a. You indicated that you have filled roles in LEADS/LEADING other than fellow. From the perspective of your non-fellow role(s), how did your experience contribute to the goal of the LEADS/LEADING Program? Qualitatively? Quantitatively?

7. Is there anything you would like to share about your LEADS/LEADING experiences (i.e., as a fellow, mentor, or in multiple roles) that the previous questions did not address?
8. Were you able to participate in the LEADS/LEADING Program to the extent that you wanted?
 - Yes
 - No

(If no, proceed to 8a. If yes, skip to 9.)

8a. What barriers or challenges prevented you from participating to the level you wanted? _____

9. Have you reached out to other LEADING/LEADS community members in the last 6 months?
 - Yes
 - No

(If yes, proceed to 9a. If no, skip to 10.)

9a. Why did you reach out to other community members? _____

10. Which type(s) of activity would you like to see offered for LEADS/LEADING community members in the future? (Select all that apply.)
 - Hot topic discussions
 - Invited speakers
 - Online discussion board/forum
 - Project after-action reviews
 - Reading group
 - Other _____

11. Have you generated any conference presentations or publications connected to LEADS/LEADING?
 - Yes, I have presented/published
 - Not yet, but I have presentations/publications planned or in progress
 - No, I have not presented/published and I don't plan to



(If yes, proceed to 11a. If not yet, proceed to 11b. If no, skip to 12.)

11a. Please provide a brief citation for each conference presentation or publication. _____

11b. Where do you plan to submit your future presentation(s) or publication(s)?

12. Please rate the following diversity, equity, and inclusion statements on how strongly you agree or disagree with them regarding your LEADS/LEADING experiences.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Not sure/NA
The LEADS/LEADING Program values diversity.					
Program leadership understands that diversity is critical to our future success.					
LEADS/LEADING invests time and energy into building diverse cohorts of fellows.					
I feel my unique background and identity (i.e., my differences) are valued by LEADS/LEADING.					
I feel a sense of belonging in LEADS/LEADING.					
I feel respected by others in the LEADS/LEADING community.					
The opportunities for involvement in LEADS/LEADING is transparent to all stakeholders.					
People from all backgrounds and with a range of identities have equitable opportunities to participate in LEADS/LEADING.					
I feel supported in my career growth by LEADS/LEADING.					

13. Is there anything you would like to share related to diversity, equity, or inclusion in LEADS/LEADING?



14. What is your gender identity? (Select all that apply.)

- Agender
- Genderqueer or genderfluid
- Māhū
- Man
- Muxe
- Non-binary
- Questioning or unsure
- Two-spirit
- Woman
- Prefer to self-describe _____
- Prefer not to say

15. Would you describe yourself as transgender?

- Yes
- No
- Prefer not to say

16. How do you identify? (Select all that apply.)

- Aromantic
- Asexual
- Bisexual
- Demiromantic
- Demisexual
- Fluid
- Gay
- Lesbian
- Pansexual
- Queer
- Questioning or unsure
- Same-gender-loving
- Straight (heterosexual)
- Prefer to self-describe _____
- Prefer not to say

17. How do you identify? (Select all that apply.)

- Asian (For example: Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese, etc.)
- Black or African (For example: African American, Jamaican, Haitian, Nigerian, Ethiopian, Somalian, etc.)
- Hispanic, Latina/o/x, or Spanish origin (For example: Mexican or Mexican American, Puerto Rican, Cuban, Salvadoran, Dominican, Colombian, etc.)
- American Indian or Native Alaskan (For example: Navajo Nation, Blackfeet Tribe, Mayan, Aztec, Native Village of Barrow Inupiat Traditional Government, Nome Eskimo Community, etc.)



- Pacific Islander or Native Hawaiian (For example: Hawaiian, Samoan, Chamorro, Tongan, Fijian, Marshallese, etc.)
 - Middle Eastern or North African (For example: Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian, etc.)
 - White (For example: German, Irish, English, Italian, Polish, French, etc.)
 - Prefer to self-describe _____
 - Prefer not to say
18. Do you identify as a person with a disability or are you a person with accessibility needs?
- Yes
 - No
 - Prefer not to say
19. In what year were you born? _____
20. What is the highest degree you have received?
- Associate
 - Bachelor's
 - Master's
 - Doctorate
 - Other _____
21. Prior to LEADS/LEADING, had you received formal training or education in any of the following disciplines? (Select all that apply.)
- Data Science
 - Library and Information Science
 - Other _____
22. What is your current professional position (e.g., MLIS student, data science librarian, etc.)? _____
23. Would you be interested in participating in a follow-up interview about your experiences in the LEADS/LEADING Program(s)?
- Yes
 - No

(If yes, proceed to 23a. If no, skip to end.)

23a. Please provide an email address where we can contact you to set up a follow-up interview _____



Appendix B

Semi-structured Interview Schedule

1. Can you tell me a bit about how you got involved in the LEADS/LEADING Program?
2. What were you hoping to get out of your experience with the program?
3. What were the most and least valuable aspects of your experience in the program?
4. The program's goals include fostering collaboration and community development to enable "a culture of mutual growth and continued sharing across the LEADING network." What strategies do you think the program's personnel should use to grow this community?
5. Are there any challenges or barriers that you think might hinder the development of this community?
6. What would make/has made you want to continue your involvement in the community beyond your initial commitment to the program?
7. Is there anything else that you'd like to add?

Appendix C

Pseudonyms for Quoted Survey Respondents and Their Role(s) in LEADS and LEADING.

Pseudonym	Role(s)	Program(s)
Ari	Fellow	LEADING
Ash	Fellow	LEADING
Blake	Fellow	LEADING
Brooke	Mentor	LEADS
Colleen	Fellow	LEADS
David	Fellow	LEADS
Dieter	Fellow	LEADS
Eve	PI, Faculty	LEADS, LEADING
Frances	Fellow	LEADING
Gayatri	Fellow	LEADING
Harper	Mentor	LEADING
Heidi	Fellow	LEADS
Ifeoma	Fellow	LEADING
Ji-an	Fellow	LEADING
Jordan	Fellow	LEADS



Kay	Fellow	LEADS
Lisa	Mentor	LEADING
Luc	Mentor	LEADS, LEADING
Michelle	Mentor	LEADING
Nora	Fellow	LEADING
Oscar	Faculty	LEADING
Parker	Fellow, Faculty	LEADS, LEADING
Peter	Mentor, Faculty	LEADS, LEADING
Ruby	Fellow	LEADING
Sarah	Mentor	LEADING
Sofia	Mentor	LEADING
Tate	Fellow	LEADS
Torsten	PI, Mentor	LEADS, LEADING
Wade	Faculty	LEADS, LEADING

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