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Full-Length Paper

Translating Liaison Librarians
to the Scientific Community

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Abstract

Objective: This study explores the root causes that undermine successful collaborations between scientists and their library liaisons to improve outreach to this population.

Methods: This paper uses the Five Whys Technique to explore the reasons why many scientists are unaware of the breadth of services offered by liaison librarians. Existing outreach strategies that address these obstacles are interpreted through the lens of implementation science theories and process models, including Normalization Process Theory.

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Abstract Continued

Results: A total of four recommendations—two for liaison librarians and two for libraries as institutions—are provided to enhance the perceived value of liaison services. The recommendations for individuals include aiming to understand scientists' needs more comprehensively and actively increasing the visibility of services that respond to those needs. Those for libraries focus on cross-functional teams and new forms of assessment.

Conclusions: These recommendations emphasize the benefits of collaboration to liaisons, to library programs at large, and to the faculty that liaisons serve. Implementation science can help librarians to understand why certain outreach strategies bring success, and how new services can be implemented more effectively.

Introduction

Liaison librarian roles have transformed in response to the eScience research environment. Adapting to the changing needs of scientists requires liaisons to expand their traditional roles in reference and collection development to provide guidance in areas like data management, scholarly communications, and systematic reviews. Yet despite this diverse expertise, scientists are often unaware of the breadth and depth of liaison services.

This paper examines existing outreach strategies through the lens of implementation science, a research field focused on moving innovations more quickly and efficiently into practice. By explaining why certain outreach strategies are successful, existing recommendations can be implemented more strategically. Through these analyses, we recommend steps that can be taken by both individual librarians and institutions to increase the perceived value of liaison services. The recommendations for librarians include developing a deeper understanding of scientists' needs and actively increasing the visibility of services that respond to those needs, while those for libraries demonstrate the value of cross-functional teams and emphasize the need for new forms of assessment.

Literature Review

The first references to liaison librarians in academic libraries began in the early 1970s, often used interchangeably with "subject specialists." Liaisons at this time were primarily department-based and considered experts at the intersection of librarianship and the subject of the department they supported. Over the following decades, these librarians have developed an increasingly broad range of responsibilities in the university. Miller and Pressley (2015) reported on these new roles through multiple surveys conducted at 67 Association of Research Libraries (ARL) member institutions. Besides new competencies, they found that the extent of collaboration between librarians and researchers was also growing. Liaisons are increasingly integrated in the research lifecycle of their departments and are even developing relationships with non-academic units at their universities including athletic departments, career centers, and campus diversity groups.

Liaisons have been adapting in response to the myriad information and data needs presented by research 2.0 or eScience, the new paradigm of scientific research that is defined by increased interdisciplinary collaboration, computational methods, and data-intensive approaches (Garritano & Carlson 2009; Koltay 2019; Tenopir et al. 2014). The proposed involvement of liaison librarians includes everything from the management and curation of research data to evaluating and assisting in scholarly publishing and research impact, providing systematic or scoping reviews, and even co-teaching with faculty (Johnson 2018). Allen and Chavez (2018) discuss how the liaison program models at the University of South Florida Libraries have evolved from academic appointments for particular departments or subjects to positions providing expertise that many or all disciplines might benefit from, such as research support, data management, or intellectual property expertise.

Researchers themselves have been slow to notice or embrace these changes. In a survey of 323 medical library users, Tennant et al. (2006) found that only 43% were aware of liaison services, despite 72% knowing the identity of their assigned liaison. Even when liaisons are visible to their users, they may not be seen as having the necessary expertise to be collaborators (Koltay 2019; Seale & Mirza 2019). Furthermore, many libraries may have begun offering research data management services too late, with the consequence that "researchers themselves started supporting themselves, because the library might not have shown any clear intention to provide services" (Koltay 2019, p. 76).

Although many of these trends apply to liaison librarians assigned to departments across all academic disciplines, the situation is especially dire in the sciences. Bright (2018) found in a survey of 2,650 liaisons that "respondents who supported STEM areas expressed more negative faculty relationship building experiences" (p. ii). Science liaison librarians therefore have a particularly urgent need to build credibility and rapport if they are to realize their goal of a more collaborative service model. As Palumbo, Bussman, and Kern note, "a liaison's communication with science faculty and students is critical for meeting their teaching, learning, and research needs" (2021, p. 599).

Liaison librarians are aware of these challenges and have sought diverse solutions to communicating their new capacities. These include deploying outreach strategies to improve upon engagement with faculty (Buehler 2020; Silver 2014), or even incorporating marketing as a formal requirement in librarianship degrees (Polger & Okamoto 2013). The University of Florida conducted a study on the effectiveness of its liaison librarian program and found that despite a widespread lack of awareness about the roles of liaisons, the faculty, staff, and students who utilized their services were satisfied with the program and would recommend it to others to use in the future (Tennant et al. 2006).

Methods

The authors are part of a graduate student cohort participating on an IMLS Laura Bush 21st Century Librarian Program grant (RE-13-19-0027-19). The Collaborative Analysis Liaison Librarians (CALL) project studies the evolving roles of science liaison librarians and the information needs of the scientists with whom they collaborate. This paper discusses the results of an exercise intended to allow the authors to establish a foundation in the literature during the first semester of their graduate program and to explore existing recommendations for improving outreach to scientists. Following this exercise, we reviewed models from the field of implementation science and used these theories to explore why certain outreach strategies are successful and how they can be implemented more effectively. We reviewed these models because translational research, implementation science, and the diffusion of innovation (DOI) theory are frameworks for increasing visibility and the uptake of something new. An IMLS grant objective is increasing collaborative potential between researchers and their liaisons.

The first step of this exercise was to employ the Five Whys Technique to explore the myriad causes of a problem and to illuminate mitigation strategies. The Five Whys Technique was first developed by Toyota Motor Company in the 1930s (Liker 2004). It consists of asking the question "Why?" five times to get to the root cause of a problem. By continuing to ask "Why?" it is possible to explore the cause-and-effect relationships between a problem and the root cause. This technique also teaches users to identify the various additional factors that may cause a problem along the way. Figure 1 showcases a visual template for following the Five Whys Technique (Serrat 2017).
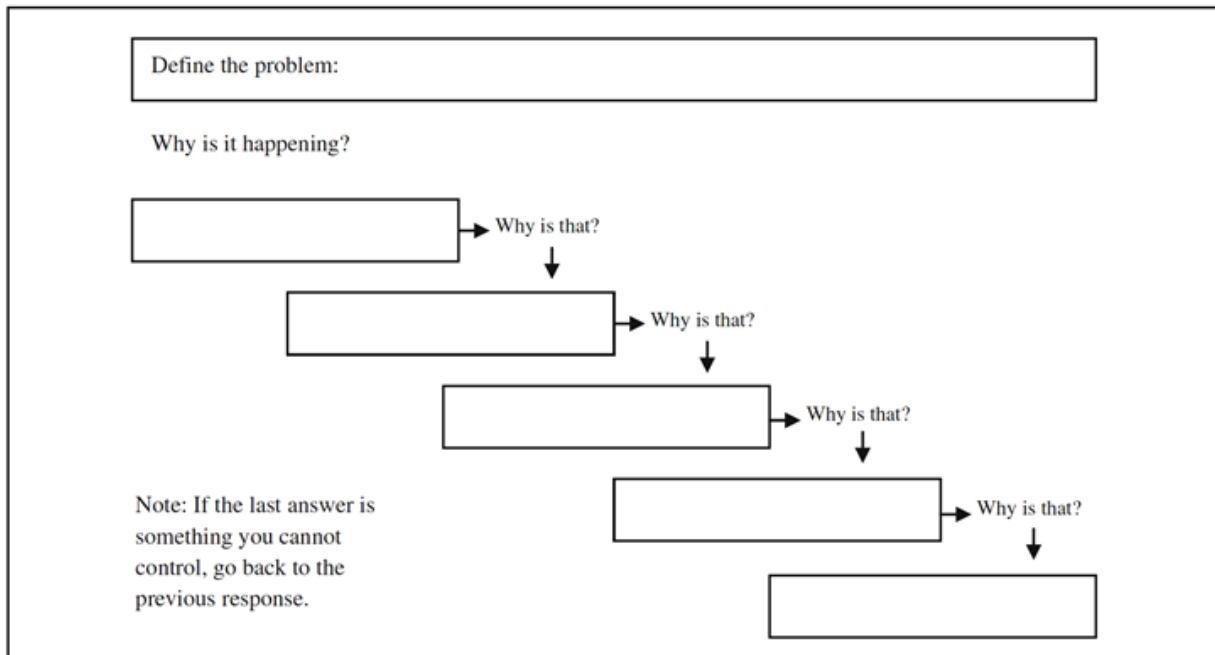

Figure 1: The Five Whys Technique. From "The Five Whys Technique," by O. Serrat, *Knowledge solutions: Tools, methods, and approaches to drive organizational performance* (p. 309), 2017, Singapore: Springer. Copyright 2017 by Asian Development Bank.

The student research group was asked to focus on intermediary challenges between a problem (scientists do not go to academic libraries to meet their information needs) and a predetermined root cause (scientists are unaware of liaison services). While it is typical of the Five Whys Technique to begin by defining the problem, the root cause is not usually identified until the conclusion of the process. However, the objective in this study is not to uncover a previously unknown root cause. As demonstrated in the preceding literature review, there is already evidence that scientists are unaware of the breadth of liaison services. Our study explores the intermediary causes to highlight the variety of ways in which liaison librarians can intervene through outreach.

These points of possible intervention are referred to in the Five Whys Technique as countermeasures or mitigation strategies (Liker 2004). By analyzing each

intermediate issue between the problem and the root cause, the user can develop strategies to prevent each problem from happening in the future, or that could assist in reducing the negative impacts from those problems. Creating countermeasures for each identified interim problem contributes to the overarching goal of addressing the root cause of a problem instead of solving it only in the short-term (Liker 2004).

Although countermeasures offer possible solutions to the problems identified with the 'Five Whys' methodology, they are not necessarily operationalized into clear steps for enactment. To produce actionable recommendations, the countermeasures were considered through the lens of theoretical and practical models of implementation science. The progenitor of these models is Diffusion of Innovation (DOI), a theory long used in business and economics to explain consumer behavior in response to new technologies (Rogers 1995). DOI has more recently transformed into a new branch of scientific research known as translational research. Rather than focusing on knowledge generation as an end, translational research prioritizes studies with practical applications and is contrasted with so-called basic research. While translational research methods have been widely adopted across disciplines, they are especially common in medical research. The final stage of translational research activities is often referred to as implementation science, the study of how knowledge is disseminated and adopted into clinical practice (Mayo Clinic 2021; Westfall et al. 2007).

This paper uses Nilsen's (2015) tripartite division of implementation science into theories, process models, and evaluation frameworks. Implementation theories provide "a clear explanation of how and why specific relationships [of variables] lead to specific events" (Nilsen 2015, p. 2). Many implementation theories describe these variables as barriers and enablers of a desired behavior or outcome. In contrast to theory, process models and evaluation frameworks provide concrete instructions for implementation and its subsequent assessment. Often, they make use of a specific theoretical model, especially its characterization of barriers and enablers. Examples of each type of implementation research were considered to identify how the countermeasures could be transformed into actionable recommendations for improving scientists' awareness of and engagement with liaison librarians.

Findings

This paper uses the Five Whys Technique to identify the intermediary steps between a behavior (scientists do not go to academic libraries to meet their information needs) and its root cause as identified through the literature review (scientists are unaware of liaison services). Because the same root cause can be precipitated by multiple issues, two research groups worked independently to develop two pathways for comparison. One group used a deductive approach, brainstorming a pathway before consulting the literature to confirm or revise the pathway, while the other group used an inductive approach, initially looking to the

literature to identify issues to create a pathway. Both strategies required multiple rounds of iteration over two weeks to develop pathways that flowed sequentially and were supported by the literature. During this work, the groups used a combination of synchronous and asynchronous online communication including video conferencing, instant messaging, shared documents, and a citation management system.

Deductive Pathway

> **The problem**: *The researcher doesn't go to an academic library to get information.*
>
> **Why is that?** *The researcher preferred to search on their own.*
>
> **Why is that?** *People prefer the method requiring the least effort when searching for information and see consulting an academic library as more effort.*
>
> **Why is that?** *It takes more effort to contact a librarian because the library has not established a relationship with the research community.*
>
> **Why is that?** *There is a lack of communication between individual researchers and librarians.*
>
> **Root cause**: *They didn't know the capabilities of a science liaison librarian.*

Like information seekers of all types, scientists often prefer to search on their own (Markey 2019) because easy access is a crucial determinant of information-seeking behavior (Allard, Levine & Tenopir 2009; Bates 2005). Researchers may perceive outreach to the library as more effort because there are not strong relationships between the library and research community, on the institutional or individual level (Bates & Delaney 2015; Bryant et al. 2020; Gibson & Dixon 2011). Often this is despite perceived effort by both groups to develop relationships. For example, Brown and Swan (2007) found in interviews with researchers and librarians that both felt they were the ones responsible for initiating contact.

Inductive Pathway

> **The problem**: *The researcher doesn't go to an academic library to get information.*
>
> **Why is that?** *The researcher views their department and field as self-sufficient.*
>
> **Why is that?** *The researcher historically has their needs met by turning to their department faculty and colleagues in their field for information.*
>
> **Why is that?** *Beginning with their undergraduate education, the researcher never received library instruction.*
>
> **Why is that?** *Librarians' contributions to research are undervalued or misunderstood in the university setting.*
>
> **Root cause**: *They didn't know the capabilities of a science liaison librarian.*

Scientists often meet their information needs within their own communities, by consulting their department faculty and colleagues (Birdsall 1992). This is a strategy that is learned early in their careers, as students in undergraduate STEM programs are less likely to receive library instruction than students in other programs of study (Quigley & McKenzie 2003). A lack of early exposure to library services is compounded by the fact that "academic librarians often find themselves without a named and acknowledged role" in research, providing services that users may interpret as administrative support rather than knowledge generation (Applegate 2019, p. 302). Regardless of whether they have faculty status in their institutions, librarians' roles are not always understood or valued.

Countermeasures

As mentioned previously, a component of the Five Whys methodology is the exploration and introduction of countermeasures to combat the issues proposed at all stages of the Five Whys. After the initial Five Whys exercise, each group was asked to explore possible countermeasures for at least three of the five whys, including the root cause. The inductive pathway group started from the root cause and worked backwards, establishing countermeasures for the root cause and the two whys preceding. The proposed countermeasures all focus on visibility and the forms of collaboration liaison librarians can participate in to increase their visibility, such as partnering with other organizations on campus (Healy 2010), embedding a liaison librarian into first-year STEM courses (Zhang et al. 2015; Ferrer-Vinent & Carello 2008), and establishing a Research Platform Team, modeled after University of South Florida Libraries (Allen & Chavez 2018).

The deductive pathway group approached countermeasures by looking at the Five Whys collectively, developing four categories of countermeasures that address the Five Whys as a whole. Those categories are: Know the researcher needs (Johnson 2018; Miller & Pressley 2015), assess outcomes and communicate them (Corrall 2015; Cox 2016; Falcone 2016), create "research commons'' spaces (Corrall 2015; Luckert 2016), and take individual relationship building seriously (Eldridge et al. 2016; Oliver et al. 2019). Ultimately, all these proposed countermeasures address the root cause and emphasize collaboration: collaboration amongst liaisons, collaboration with other University partners, and collaboration with researchers. These countermeasures are the foundation for this paper's recommendations, and implementation science is the vehicle used to transform those countermeasures into recommendations.

Implementation Models

Each countermeasure is ultimately concerned with changing a behavior to mediate the problem. As a result, the most relevant implementation theories are those that describe the necessary conditions for sustained changes in behavior, such as Normalization Process Theory. Also referred to as institutionalization, normalization is the final stage in the original Diffusion of Innovation model and indicates that what was formerly innovative is now routine. May and Finch (2009)

describe normalization as four iterative, non-sequential processes that relate to how individuals both understand and participate in a new activity. Table 1 displays these four concepts alongside the operational questions they invoke and the investment which they require. The operational questions identified in this table are used in the recommendations section to demonstrate how liaison outreach strategies can promote normalization.

Table 1: Stages of Normalization Process Theory (Table by authors, Adapted from May and Finch (2009), *Sociology*, p. 547-9, tables 1 and 2).

	Coherence	**Cognitive Participation**	**Collective Action**	**Reflexive Monitoring**
Operational question	What is the work?	Who does the work?	How does the work get done?	How is the work understood?
Investment	Meaning	Commitment	Effort	Comprehension

Key to these operational questions are people and the institutions they operate within. Grol and Wensing (2004) identify six individual and organizational levels at which barriers or enablers to normalization might occur. With some adaptation from the context of healthcare to that of the university library, these levels are: the feasibility of the new behavior itself; the motivations and knowledge of both individual librarians and individual researchers; the social norms of the institution, including its leadership and culture; organizational factors such as size and departmental structures; and economic factors. Identifying which of these levels will impede or move forward a behavior is essential for implementing realistic outreach strategies that facilitate normalization. This is inherently dependent on the specific context and will vary by the individuals and institutions involved.

But while the local context should always be accounted for, there are some common strategies to addressing barriers and encouraging enabling factors. Implementation science scholars have designed numerous "process models"—generalized frameworks focused on stages of implementation that are common across different contexts. This turns the focus from local context to the factors that are associated with a particular phase of implementation in general. For example, an early stage of implementation may benefit from a top-down communication style, whereas collaboration is more successful during later stages. Most importantly, process models allow for the examination of factors that aid in moving *between stages*. Davis et al.'s (2007) process model identifies the concept of "linking agents." These are internal constituents with "sufficient knowledge about an innovation and the adopting social system to act as a bridge between resource and user systems" (p. 3). While librarians have a long history as campus

connectors, it is important for successful outreach that they recruit as many additional linking agents as possible.

Recommendations

The following four recommendations are a distillation of the countermeasures. These were originally identified as mitigation strategies for the problems identified through the five whys technique, but they have been combined and modified to incorporate the concept of normalization. While the audience of this paper leads us to make recommendations only for libraries and librarians, we have included proposed "linking agents" for each recommendation, as a reminder that the process will require constituents from across the university.

Recommendation 1: Liaison librarians should be proactive in assessing researcher and department needs.

What is the work?	Who does the work?	How does the work get done?	How is the work understood?
Identifying and preparing for collaborative opportunities	**Primary:** Liaison librarians **Linking Agents:** LIS faculty; LIS professional associations	Needs assessments; LIS education; Continuing education	Given time and resource constraints, it is necessary to prioritize service options.

Liaison librarians themselves must be normalized to a new type of collaborative research. An essential first step in this normalization is ensuring that they know–rather than guess–the needs of the researchers they work with (Johnson 2018; Miller & Pressley 2015). Needs assessments can be achieved through several different strategies such as focus groups and surveys, direct communication and conversations, and the review of written information from departments and researchers (i.e., strategic plans, websites, and faculty bibliometrics). Needs assessments are the groundwork for effective outreach, especially given the wide array of service offerings available.

It is equally important that current and future liaisons are prepared to meet the needs that are identified through these assessments. This includes sufficient continuing education opportunities as well as the addition of courses focused on science librarianship in LIS curricula. Ensuring new graduates enter the workforce with the skills and training necessary to understand the needs of researchers and their departments is imperative. However, improved education can provide a basis, but cannot replace the on-the-job experiences that lead to an understanding of the unique needs of a specific institution's researchers.

Recommendation 2: Liaison librarians should actively seek out opportunities to increase their visibility and enhance perceived value.

What is the work?	Who does the work?	How does the work get done?	How is the work understood?
Developing relationships.	**Primary:** Liaison librarians **Linking Agents:** STEM faculty; Campus partners (Office of Research, Office of Technology, research institutes)	Embedded library instruction; Faculty outreach; Joint workshops and programming	Scientists value library services when they are exposed to them.

Whereas the first recommendation focuses on normalizing liaisons to a more collaborative model, this recommendation emphasizes normalization for scientists. Embedding library instruction in first year STEM courses can increase the visibility of science liaisons and lead scientists to more consistent use of library resources throughout their careers (Ferrer-Vinent & Carello 2008; Zhang et al. 2015). In addition to embedding library instruction in first-year courses, it would be prudent to have students complete a yearly refresher course regarding the services the library—and liaison librarians—has to offer. Involving library staff in earlier stages of STEM programs can help establish long-term habits of understanding library services and turning to library staff.

Liaison librarians can further demonstrate their value to the campus community by working with organizations on campus to increase their visibility. Healy (2010) found that by connecting with student and faculty organizations on campus, new communication avenues opened and allowed librarians additional opportunities to promote library services. Another study that utilized focus groups to assess researchers' opinions of the library services at the University of Kansas revealed that the faculty lacked the time to discover what services the library could provide them with (Johnson 2018). To better convey the value of liaison librarians to scientists, it would be helpful to create a better flow of communication between the liaisons and the faculty in a department (rather than only communicating between a liaison and the department head). Potential offerings from the liaison librarians could include a workshop to help the faculty understand the services offered, an email service to remind researchers of the liaisons' availability, or pop-up advertisements on the library's research portal.

Recommendation 3: Libraries should form cross-functional teams for both the implementation and the ongoing operations of liaison models.

What is the work?	Who does the work?	How does the work get done?	How is the work understood?
Responsive organizational structuring.	**Primary:** Library administration **Linking Agents:** Campus administration; Campus partners (Office of Research, Office of Technology, research institutes); Liaison librarians	Restructuring library departments; Joint workshops and programming; Joint hiring; Library in-reach (working groups, informal co-learning)	Supporting eScience research requires coordinated service offerings that re-imagine traditional divisions.

Existing liaison librarian models now require far more skills than any one person is likely to possess (Johnson 2020; Kranich et al. 2020), underscoring the need for collaborative liaison team models. These required skills are diverse and cover a wide array of services and expertise the library and liaisons can offer. It is no longer feasible for a single liaison to be proficient in every skill. Kranich et al. (2020) emphasizes the need for enhanced liaison teams that pool together the specialized knowledge multiple colleagues contain and work together to communicate this shared knowledge. "Such transformation requires teamwork to leverage expertise and advance research" (Kranich et al. 2020, p. 290).

An example of this type of team can be seen at The University of South Florida Libraries. After examining their current liaison structure, library staff developed a new model titled the Research Platform Team (RPT) model, the purpose of which is to establish deeper relationships with researchers that lead to active participation in the research process. This model consists of four areas of focus and a variety of library staff participate in each area.

The RPT model is just one example of how libraries can restructure their liaison programs to emphasize collaboration amongst different liaison librarians and with research faculty. A special issue of Research Libraries Issues published by the Association of Research Libraries focused exclusively on this idea of transforming the liaison model into cross-functional teams to not only help alleviate the workload of individual liaisons, but to also better serve faculty research. The University of South Florida Libraries' Research Platform Team model is highlighted in this issue, as well as programs at MIT Libraries, the University of Guelph Library, University of California Riverside Libraries, and the University of Texas at Austin Libraries (Baughman and Groves 2018).

Recommendation 4: Libraries should experiment with new forms of assessment that better convey the value of liaison models and occur throughout the phases of implementation.

What is the work?	Who does the work?	How does the work get done?	How is the work understood?
Conveying impact.	**Primary:** Library administration **Linking Agents:** Campus administration; Liaison librarians; Faculty collaborators; LIS faculty	Revision of existing performance metrics; Documentation of successes and challenges; Research to validate new assessment models	Collaborative service models produce benefits that are not easily demonstrated by existing metrics.

Finally, libraries must recognize that current strategies for assessing success may not be sufficient for evaluating the new range of activities liaisons offer. When new activities are introduced, care should be taken to ensure that assessment strategies will adequately address them, and if necessary new assessment methods should be introduced. Assessment should strive to measure the success of both new and current models (Kranich 2020), and to measure the outcomes of a service, demonstrating its value (Falcone 2016).

One proposed framework for liaison assessment considers Engagement, Teaching and Learning, Collection Development and Management, Research Support, and Scholarly Communication and Digital Initiatives as five crucial components of liaison work and provides assessment strategies for each (Resnis & Natale 2020). For example, in Scholarly Communication, they suggest tracking if researchers can deposit their work in institutional repositories or publish in open access journals in part due to assistance from librarians. Or, in Research Support, detailed tracking of consultations for a better understanding of what researchers want and need from librarians.

However, they are accomplished, it is also important that assessments are both continuous and clearly communicated. By publishing assessments that occur throughout the implementation process, libraries share valuable information about how success was achieved, allowing other institutions to more readily replicate the implementation process. Assessments should also be shared with external constituents. The outcomes derived from assessments can be an important tool to demonstrate value, but to do so the findings must be communicated to users outside of the library.

Discussion

These recommendations emphasize the benefits of collaboration to liaisons, to library programs at large, and to the faculty that liaisons serve. Implementation science can help librarians to understand why certain outreach strategies are successful and how new services can be implemented more effectively. While implementation must always address local context to be successful, this paper has focused on generalizable concepts, including Normalization Process Theory and linking agents. However, there are limitations to both the recommendations and the methodologies used in this paper, highlighting a need for future research.

Serrat (2017) provides some broad critiques inherent in the Five Whys methodology, including the "low repeat rate of results" (p. 310) that can lead to vastly different conclusions for the same problem. Although we attempted to control for this possibility by intentionally identifying two distinct causal pathways, there are likely others that were not explored. Because alternate intermediate problems would also produce distinct countermeasures, the recommendations in this paper are necessarily only one set of possible mitigation strategies among others.

An additional limitation concerns the application of implementation science to librarianship. In healthcare, the intervention itself is tested in clinical trials prior to implementation. In most libraries, a particular liaison model will not have undergone such rigorous scrutiny. As a result, problems in implementation cannot readily be differentiated from problems in the liaison model itself. While our recommendations primarily focus on improving implementation, careful attention must also be paid to developing an evidence-based liaison program.

Liaison librarians' roles and job functions are unique to organizations, including their size, resources, and culture. In this paper we discuss generalizations and recognize that these proposed solutions may need to be adapted or reconsidered based on the needs of an organization. This is particularly salient regarding differences in institutional size and resources. Given the size of some liaison programs, where one librarian may be responsible for serving researchers across numerous disciplines, some of these recommendations may need to be scaled down or may not be applicable at all. These recommendations are not intended to be adopted all together by every liaison program, and the tables provided with each recommendation establish who and how a recommendation could be implemented, helping to discern which would be best for an individual liaison program. These tables also help distinguish between the roles and responsibilities of individual liaisons and those of management.

Besides being a source for implementation science research, translational research centers in the health sciences also offer a model for what increased librarian collaboration in eScience research might look like. In response to increasing quantities of medical research at the turn of the century, Davidoff and Florance (2000) proposed specialized reference services by a professional they called an

informationist. From its conception, the informationist was imagined as an embedded position that bridged content specialization and information work. While the new position was promoted by the Medical Library Association (MLA) and the National Library of Medicine (NLM), it was not always embraced by medical librarians themselves, nor by the medical researchers it purported to support (Federer 2014). Nevertheless, it has continued to grow and transform in response to user needs in data services, finding a new home within centers for translational research (Kilham 2018), and serving as a model for other forms of embedded librarianship (Federer 2014; Lyon 2016; Stowell Bracke 2017). It would be instructive to examine its history through the lens of implementation science, understanding why it has persisted and how it might be adapted in the context of information work in other science settings. Studying both what aspects of the informationist were positively received by medical researchers, as well as which aspects were negatively received can provide a fuller understanding of how to improve science liaison librarianship.

Finally, there is also a lack of research on collaborations between external science organizations and academic libraries. As a result, the preceding findings can only be speculatively extended to outreach to governmental or private industry scientific researchers. As scientific research is increasingly multi-institutional, this is an area that would benefit from further exploration.

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References

Allard, Suzie, Kenneth J. Levine, and Carol Tenopir. 2009. "Design Engineers and Technical Professionals at Work: Observing Information Usage in the Workplace." *Journal of the American Society for Information Science and Technology* 60(3): 443–54. https://doi.org/10.1002/asi.21004

Allen, Maryellen, and Todd Chavez. 2018. "The University of South Florida Libraries' Evolving Service Model: From ROLES to Research Platform Teams." *Research Library Issues* 294: 31–38. https://doi.org/10.29242/rli.294.4

Applegate, Rachel. 2019. "Librarians in the Academic Ecosystem." *Library Trends* 68(2): 295–315. https://doi.org/10.1353/lib.2019.0040

Bates, Marcia J. 2005. "An Introduction to Metatheories, Theories, and Models." In *Information and the Information Professions*, edited by K. Fisher, S. Erdelez, and L. McKechni, 256–75. New Medford, NJ: Information Today. https://pages.gseis.ucla.edu/faculty/bates/articles/metatheories.pdf

Baughman, M. Sue, and Kaylyn Groves, eds. "Research Library Issues, no. 294 (2018)." *Research Library Issues* 294: 1-80. https://doi.org/10.29242/rli.294

Birdsall, William F. 1992. "Why Don't More Faculty Love Librarians?" *Journal of Academic Librarianship* 17(6): 375.

Bright, Kawanna Michelle. 2018. "Examining the Role of Liaison Librarians as Research Collaboration Partners: A Mixed-Methods Multiple-Case Study." Ph.D., Electronic Theses and Dissertations: University of Denver. https://digitalcommons.du.edu/etd/1537

Brown, Sheridan and Alma Swan. 2007. *Researchers' Use of Academic Libraries and Their Services: A Report Commissioned by the Research Information Network and the Consortium of Research Libraries*. London, UK: Research Information Network and Consortium of Research Libraries in the British Isles. https://eprints.soton.ac.uk/263868

Bryant, Rebecca, Annette Dortmund, and Brian Lavoie. 2020. *Social Interoperability in Research Support: Cross-Campus Partnerships and the University Research Enterprise*. Dublin, OH: OCLC Research. https://doi.org/10.25333/wyrd-n586

Buehler, Nicole R. 2020. "Outreach in Public, Special, and Academic Libraries." *The Serials Librarian* 79(1–2): 57–61. https://doi.org/10.1080/0361526X.2020.1772174

Corrall, Sheila. 2014. "Designing Libraries for Research Collaboration in the Network World: An Exploratory Study." *LIBER Quarterly* 24(1): 17–48. https://doi.org/10.18352/lq.9525

Cox, John. 2016. "Communicating New Library Roles to Enable Digital Scholarship: A Review Article." *New Review of Academic Librarianship* 22(2–3): 132–47. https://doi.org/10.1080/13614533.2016.1181665

Davidoff, Frank, and Valerie Florance. 2000. "The Informationist: A New Health Profession?" *Annals of Internal Medicine* 132(12): 996–998. https://doi.org/10.7326/0003-4819-132-12-200006200-00012

Davis, Sally M., Jeffery C. Peterson, Christian D. Helfrich, and Leslie Cunningham-Sabo. 2007. "Introduction and Conceptual Model for Utilization of Prevention Research." *American Journal of Preventive Medicine* 33(1): S1–5. https://doi.org/10.1016/j.amepre.2007.04.004

Delaney, Geraldine, and Jessica Bates. 2015. "Envisioning the Academic Library: A Reflection on Roles, Relevancy and Relationships." *New Review of Academic Librarianship* 21(1): 30–51. https://doi.org/10.1080/13614533.2014.911194

Eldridge, Jeanette, Katie Fraser, Tony Simmonds, and Neil Smyth. 2016. "Strategic Engagement: New Models of Relationship Management for Academic Librarians." *New Review of Academic Librarianship* 22(2–3): 160–175. https://doi.org/10.1080/13614533.2016.1193033

Falcone, Andrea. 2016. "Practical Strategies for Demonstrating the Value of Public Services in Academic Libraries." *International Information & Library Review* 48(1): 51–56. https://doi.org/10.1080/10572317.2016.1146042

Federer, Lisa. 2014. "Exploring New Roles for Librarians: The Research Informationist." *Synthesis Lectures on Emerging Trends in Librarianship* 1(2): 1–47. https://doi.org/10.2200/S00571ED1V01Y201403ETL001

Ferrer-Vinent, Ignacio J., and Christy A. Carello. 2008. "Embedded Library Instruction in a First-Year Biology Laboratory Course." *Science & Technology Libraries* 28(4): 325–351. https://doi.org/10.1080/01942620802202352

Garritano, Jeremy, and Jake Carlson. 2009. "A Subject Librarian's Guide to Collaborating on e-Science Projects." *Issues in Science and Technology Librarianship* 57. https://doi.org/10.5062/F4639MPT

Gibson, Craig, and Christopher Dixon. 2011. "New Metrics for Academic Library Engagement." In *A Declaration of Interdependence: The Proceedings of the ACRL 2011 Conference*, 340–51. Philadelphia, PA. http://www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/confsandpreconfs/national/2011/papers/new_metrics.pdf

Grol, Richard, and Michel Wensing. 2004. "What Drives Change? Barriers to and Incentives for Achieving Evidence-Based Practice." *Medical Journal of Australia* 180(S6): S57–60. https://doi.org/10.5694/j.1326-5377.2004.tb05948.x

Healy, Annette M. 2010. "Increasing the Visibility of the Library within the Academic Research Enterprise." *Issues in Science and Technology Librarianship* 63. https://doi.org/10.5062/F43N21B7

Johnson, Anna Marie. 2018. "Connections, Conversations, and Visibility: How the Work of Academic Reference and Liaison Librarians Is Evolving." *Reference and User Services* Quarterly 58(2): 91. http://dx.doi.org/10.5860/rusq.58.2.6929

Johnson, Anna Marie. 2020. Reference and Liaison Librarians: Endangered Species or "Vital Partners?" Views of Academic Library Administrators. *Journal of Library Administration* 60(7): 784–799. https://doi.org/10.1080/01930826.2020.1786979

Kilham, Jessica. 2018. "Translating Expertise: The Librarian's Role in Translational Research, Edited by Marisa L. Conte." *Medical Reference Services Quarterly* 37(4): 433–433. https://doi.org/10.1080/02763869.2018.1514919

Koltay, Tibor. 2019. "Accepted and Emerging Roles of Academic Libraries in Supporting Research 2.0." *The Journal of Academic Librarianship* 45(2): 75–80. https://doi.org/10.1016/j.acalib.2019.01.001

Kranich, Nancy, Megan Lotts, Jordan Nielsen, and Judit H. Ward. 2020. "Moving from Collecting to Connecting: Articulating, Assessing, and Communicating the Work of Liaison Librarians." *Portal: Libraries and the* Academy 20(2): 285–304. https://doi.org/10.1353/pla.2020.0015

Liker, Dr Jeffrey K. 2004. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill Education. https://www.accessengineeringlibrary.com/content/book/9780071392310

Luckert, Yelena. 2016. "Transforming a Library: Strategies for Implementing a Liaison Program." *International Information & Library Review* 48(4): 294–300. https://doi.org/10.1080/10572317.2016.1243965

Lyon, Liz. 2016. "Librarians in the Lab: Toward Radically Re-Engineering Data Curation Services at the Research Coalface." *New Review of Academic Librarianship* 22(4): 391–409. https://doi.org/10.1080/13614533.2016.1159969

Markey, Karen. 2019. "Chapter 1: Online Searching in the Age of the Information Explosion." In *Online Searching*, 1–18. Rowman & Littlefield Publishers.

May, Carl, and Tracy Finch. 2009. "Implementing, Embedding, and Integrating Practices: An Outline of Normalization Process Theory." *Sociology* 43(3): 535–54. https://doi.org/10.1177/0038038509103208

Mayo Clinic. "Late-stage Translational Research." Center for Clinical and Translational Science (CCTS). Accessed January 7, 2021. https://www.mayo.edu/research/centers-programs/center-clinical-translational-science/community/late-stage-translational-research

Miller, Rebecca K., and Lauren Pressley. 2015. "Evolution of Library Liaisons." SPEC Kit 349. Washington, DC: Association of Research Libraries. https://doi.org/10.29242/spec.349

Nilsen, Per. 2015. "Making Sense of Implementation Theories, Models and Frameworks." *Implementation Science* 10(1): 53. https://doi.org/10.1186/s13012-015-0242-0

Oliver, Jeffrey C., Christine Kollen, Benjamin Hickson, and Fernando Rios. 2019. "Data Science Support at the Academic Library." *Journal of Library Administration* 59(3): 241–257. https://doi.org/10.1080/01930826.2019.1583015

Palumbo, Laura, Bussmann, Jeffra, & Kern, Barbara. 2021. "The Value of Subject Specialization and the Future of Science Liaison Librarianship." *College & Research Libraries* 82(4): 584–608. https://doi.org/10.5860/crl.82.4.584

Polger, Mark Aaron, and Karen Okamoto. 2013. "Who's Spinning the Library? Responsibilities of Academic Librarians Who Promote." *Library Management* 34(3): 236–253. https://doi.org/10.1108/01435121311310914

Quigley, Brian D., and Jean McKenzie. 2003. "Connecting Engineering Students with the Library: A Case Study in Active Learning." *Issues in Science and Technology Librarianship* 37. https://doi.org/10.5062/F4251G5V

Resnis, Eric, and Jennifer Natale. 2020. "Demonstrating Library Impact: Liaison Assessment." *The Journal of Academic Librarianship* 46(4): 102158. https://doi.org/10.1016/j.acalib.2020.102158

Rogers, Everett M. 1995. *Diffusion of Innovations*. 4th ed. New York: Free Press.

Seale, Maura, and Rafia Mirza. 2019. "Empty Presence: Library Labor, Prestige, and the MLS." *Library Trends* 68(2): 252–268. https://doi.org/10.1353/lib.2019.0038

Serrat, Olivier. 2017. "The Five Whys Technique." In *Knowledge Solutions: Tools, Methods, and Approaches to Drive Organizational Performance*, 307–10. Singapore: Springer. https://doi.org/10.1007/978-981-10-0983-9_32

Silver, Isabel D. 2014. "Outreach Activities for Librarian Liaisons." *Reference & User Services Quarterly* 54(2): 8–14. https://doi.org/10.5860/rusq.54n2.8

Stowell Bracke, Marianne. 2017. "Agricultural Librarians Becoming Informationists: A Paradigm Shift." *Library Trends* 65(3): 448–466. https://doi.org/10.1353/lib.2017.0011

Tennant, Michele R., Tara Tobin Cataldo, Pamela Sherwill-Navarro, and Rae Jesano. 2006. "Evaluation of a Liaison Librarian Program: Client and Liaison Perspectives." *Journal of the Medical Library Association* 94(4): 402-e204. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1629425

Tenopir, Carol, Robert J. Sandusky, Suzie Allard, and Ben Birch. 2014. "Research Data Management Services in Academic Research Libraries and Perceptions of Librarians." *Library & Information Science Research* 36(2): 84–90. https://doi.org/10.1016/j.lisr.2013.11.003

Westfall, John M., James Mold, and Lyle Fagnan. 2007. "Practice-Based Research—'Blue Highways' on the NIH Roadmap." *JAMA* 297(4): 403. https://doi.org/10.1001/jama.297.4.403

Zhang, Qinqin, Maren Goodman, and Shiyi Xie. 2015. "Integrating Library Instruction into the Course Management System for a First-Year Engineering Class: An Evidence-Based Study Measuring the Effectiveness of Blended Learning on Students' Information Literacy Levels." *College and Research Libraries* 76(7): 934–958. https://doi.org/10.5860/crl.76.7.934