Published in final edited form as:

Sci Technol Libr (New York, NY). 2013 ; 32(2): 160–175. doi:10.1080/0194262X.2013.791183.

Librarians as Part of Cross-Disciplinary, Multi-Institutional Team Projects: Experiences from the VIVO Collaboration

Rolando Garcia-Milian^{1,*}, Hannah F. Norton^{1,*}, Beth Auten¹, Valrie I. Davis², Kristi L. Holmes^{3,4}, Margeaux Johnson², and Michele R. Tennant^{1,5}

¹University of Florida Health Science Center Libraries, Gainesville, FL

²Robert Marston Science Library, University of Florida, Gainesville, FL

³Bernard Becker Medical Library, Washington University School of Medicine, St. Louis, MO

⁴Washington University Institute of Clinical and Translational Sciences, St. Louis, MO

⁵University of Florida Genetics Institute, Gainesville, FL

Abstract

Cross-disciplinary, team-based collaboration is essential for addressing today's complex research questions, and librarians are increasingly entering into such collaborations. This study identifies skills needed as librarians integrate into cross-disciplinary teams, based on the experiences of librarians involved in the development and implementation of VIVO, a research discovery and collaboration platform. Participants discussed the challenges, skills gained, and lessons learned throughout the project. Their responses were analyzed in the light of the science of team science literature, and factors affecting collaboration on the VIVO team were identified. Skills in inclusive thinking, communication, perseverance, adaptability, and leadership were found to be essential.

INTRODUCTION

Successful approaches to global challenges such as climate change, complex biomedical research questions, food shortages, and sustainable energy use increasingly necessitate the use of cross-disciplinary and multi-institutional team collaboration. Diverse collaborative teams are able to bring more innovative solutions to the research effort, maximize breakthroughs while minimizing failures, and optimize dissemination of gained knowledge in a broad and efficient manner (Disis and Slattery 2010). This collaborative team approach is not only required during the research process, but also during implementation of solutions (Börner et al. 2010). Recent years have seen an increase in the level at which librarians participate on collaborative teams outside the library, for example, as members of rounding patient care teams, systematic review teams, Institutional Review Boards, embedded librarians/informationists on research teams and a variety of campus committees (Aitken et al. 2011, Moore 2011, Bandy et al. 2008, Urquhart et al. 2007). In addition, librarians are playing emerging roles in the support of clinical and translational research efforts (Holmes and Dubinsky 2009) as well as e-science and data management initiatives (Gold 2007, Rambo 2009). Although these efforts may require that librarians become part of cross-disciplinary, and, in some cases, multi-institutional teams, their experience on collaborative projects of this scale may be limited.

Address correspondence to: Rolando Garcia-Milian, Basic Biomedical Sciences Librarian, Biomedical & Health Information Services Department, University of Florida Health Sciences Center Library, PO Box 100206, Gainesville, FL 32610-0206. rolando.milian@ufl.edu.

*Both the first and second authors contributed equally to this article.

For two years, librarians across seven participating institutions were a core part of the multidisciplinary, multi-institutional VIVO team (<http://www.vivoweb.org/>) as collaborators on an American Recovery and Reinvestment Act funded project from the National Institutes of Health (NIH) to the University of Florida (VIVO 2009). VIVO is a semantic web application designed to enable discovery and collaboration among researchers and the project covered a wide range of efforts, including software and ontology development, implementation, and adoption, with librarians most often involved in implementation and adoption activities. Based on VIVO team members' experiences, this study identifies and analyzes factors that influence team collaboration dynamics and those skills needed as librarians integrate into large, cross-disciplinary, and multi-institutional teams.

BACKGROUND

Team Science

As cross-disciplinary research and large-scale research grows, scholarly interest in studying processes of collaboration, teamwork, and cross-disciplinary research also grows. Thus the *science of team science* field has emerged, a field that uses both conceptual and methodological strategies to understand and improve the functional aspects of team science projects as well as their outcomes (Stokols et al. 2008a). Understanding the nature of teams, teamwork, and team performance in order to promote team effectiveness has been an arduous endeavor undertaken in several scientific disciplines.

An early element of existing conceptual work within the science of team science field has been defining key terms, particularly distinguishing among different types of collaboration that may occur in team science projects. The term *cross-disciplinary collaboration* covers all interactions in which team members have been drawn from different disciplines but does not qualify the form of interaction among these team members. Cross-disciplinary collaborations can be described more specifically as multidisciplinary, interdisciplinary, or transdisciplinary. Collaboration is *multidisciplinary* when team members from different disciplines coordinate their efforts to achieve a common goal but contributions from each discipline are complementary rather than integrative, typified by independent work that is then shared with the group. *Interdisciplinary* collaborations involve more direct interaction among team members from different disciplines; team members work jointly and strive towards integrating their perspectives while remaining anchored in their disciplines. *Transdisciplinary* collaborations often occur over longer time periods and allow team members to integrate the analytical strengths of their disparate disciplines to create new hybrid methods, concepts, and ideas (Rosenfield 1992, Fiore 2008, Stokols et al. 2008a).

A number of authors in the science of team science field have identified groups of skills, competencies, and environmental factors vital for collaboration in general and team science in particular. Necessary elements most frequently mentioned throughout the literature include effective communication across the team, leadership and managerial skills, an environment of trust among team members, shared expectations, and clearly defined roles and responsibilities (Nash et al. 2003, Burke et al. 2006, Bennett et al. 2010, Lynch 2011). Aspects of team members' attitudes and values also impact team effectiveness; desirable attitudes and values among cross-disciplinary team members include valuing collaboration, openness and respectfulness to contributions of other disciplines, willingness to venture outside one's own area of expertise, optimism, an awareness of one's own limits, inclusive thinking, a high tolerance for change, and a spirit of inquiry (Nash et al. 2003, Burke et al. 2006, Lynch 2011).

The literature also reports challenges and obstacles that can slow or prevent collaborative efforts from succeeding. Besides personal and interpersonal dynamics (Stokols et al. 2008a),

recognition, review, and reward of collaborative teamwork have been identified as centrally important to supporting team development. In general, there are few mechanisms available to review or give credit for teamwork, and the academic reward (particularly tenure and promotion) structure's tendency to focus on individual achievement can be discouraging for younger faculty participating in collaborative teams (Bennett et al. 2010). Lack of training has been recognized as another obstacle. In response, Fiore recognizes a need for training in "interdisciplinarity" and teamwork skills, based on both the varied levels and types of expertise within the team (Fiore 2008).

Stokols and colleagues developed a model of factors (both positive and negative) influencing team collaboration that further categorizes many of the elements described above. This model defines contextual factors that influence team collaboration: intrapersonal (e.g. members' attitudes toward collaboration, their preparation for complexities and tensions, leadership styles); interpersonal (e.g. members' familiarity, their ability to adapt to changing tasks, regular and effective communication); physical environmental (e.g. spatial proximity of team members); technological (e.g. infrastructure readiness, members' technological readiness); and organizational (e.g. presence of organizational incentives to support collaboration, non-hierarchical organization structures) (Stokols et al. 2008b). Given its clarity and comprehensiveness, this model was used to organize and analyze the feedback from VIVO team members on their experiences in this cross-disciplinary project.

Librarians and cross-disciplinary teams

Librarians have been part of collaborative teams outside the library for quite some time; biomedical science librarians participate on patient care teams as clinical librarians, systematic review teams, members of their Institutional Review Board, embedded librarians/informationists on research teams and various campus committees (Aitken et al. 2011, Moore 2011, Bandy et al. 2008, Urquhart et al. 2007). Embedded science librarians have been partners with faculty in curriculum design and co-teaching (Pritchard 2010), as well as in team-taught courses in scientific writing for undergraduate students (Huerta and McMillan 2004). A recent study showed that biomedical librarians are increasingly becoming incorporated into sponsored research (as project staff members) not only in the process of grant proposal writing but also in developing and co-authoring the resulting manuscripts (Glenn and Rolland 2010).

Martin studied characteristics of effective teams and barriers to team effectiveness within the library context using a pre-existing multidimensional model of team effectiveness and outcomes (Martin 2006). Although many positive characteristics and barriers fit into this structural and process-oriented framework, library personnel highlighted additional personality and behavioral characteristics that impacted team effectiveness. In particular, positive "teaming" characteristics included group harmony, collegiality, non-competitiveness, trust, and a blame-free environment while barriers to team effectiveness included lack of trust, lack of group identity, lack of harmony, and group conflict (Martin 2006). This emphasis on team dynamics and interpersonal relationships may be challenging for librarians when they partner with scientists on interdisciplinary teams, as scientists have been found to be less concerned with adhering to group norms, more introverted, and less conscientious than those in other occupations (Lounsbury et al. 2012). Other challenges encountered by librarians as part of teams outside of the library include irregular timelines, providing education to their collaborators, and learning new technologies for record keeping (Dudden and Protzko 2011).

Among the rewards of collaborative team experiences are building relationships with researchers, expanding professional expertise, and receiving recognition for contributions to health care outcomes (Dudden and Protzko 2011). Developing critical appraisal skills and a

greater understanding of the challenges caregivers face, as well as learning the language and unspoken conventions of the clinical community are also mentioned (Bandy et al. 2008).

In this paper we will examine the cross disciplinary, multi-institutional project, VIVO, as a case study for collaboration between scientific researchers and librarians.

VIVO

VIVO is a research networking tool built on semantic web technologies that is designed to enable discovery and collaboration among researchers. What distinguishes VIVO from other computer-mediated social networks is that the system harvests much of its data from public, authoritative sources such as institutional directories, sponsored research (grants) databases, publication databases, and faculty reporting systems. This minimizes researchers' involvement in populating their own profiles and improves accuracy and consistency across profiles (Krafft et al. 2010). The result is a fully searchable web-based platform that showcases a variety of individual, institutional, and departmental information from across the scholarly ecosystem. VIVO's interlinked profiles, along with other network visualization tools, allow the research community to discover content and find potential collaborators across disciplines (Holmes et al. 2010).

VIVO was originally developed at Cornell University. The seven institutions that make up the VIVO Collaboration (University of Florida, Cornell University, Indiana University, Ponce School of Medicine, The Scripps Research Institute, Washington University in St. Louis School of Medicine, and Weill Cornell Medical College) were awarded a \$12.2 million National Institutes of Health (NIH) grant in 2009 in order to expand this tool for national use. Beyond the grant-funded VIVO Collaboration institutions, many other organizations across the public and private sectors have become involved with this open-source project by downloading and implementing the software at their own institution, by developing additional tools that use VIVO data, and by providing rich data for VIVO implementations.

Librarians have played a central role in the support, development, and adoption of campus-wide VIVO networks from the beginning of the project (Davis et al. 2009). Some of these roles include: developing core and local ontologies, locating and selecting subject vocabularies, developing user-centered interface design, engaging potential users through presentations and demonstrations, performing usability studies and focus groups, providing local support and training on the system, engaging with local and external data providers, and providing project management leadership and assistance with governance (Russell Gonzalez et al. 2010, Holmes et al. 2010). In carrying out these responsibilities, librarians participated in interdisciplinary collaboration, working with other members of the VIVO team as well as local implementation partners including information technologists, computer scientists, programmers, and biomedical researchers.

Russell Gonzalez and colleagues described VIVO as a unique opportunity to realign the library with the mission and goals of the institution, and to reposition the library as a full partner in scholarly research. Librarians can benefit from VIVO by using the tool to monitor individual user and departmental activities, creating their own profiles, and showcasing library resources and services (Russell Gonzalez et al. 2010).

METHODS

A group of library professionals composed of six biomedical librarians and two science librarians from the University of Florida (UF) as well as a bioinformatician from Washington University in St. Louis School of Medicine participated in this study. This

represented all interested librarian VIVO team members at UF as well as a key collaborator at the national level. These librarians had varying roles and degrees of responsibility within the implementation and outreach teams of the VIVO project, ranging from spending 0–80% of their time on VIVO implementation and from 5–50% of their time on VIVO outreach. Using the phenomenological approach, data were collected through semi-structured interviews in which participants were individually asked to identify perceived challenges, skills gained, and lessons learned during the VIVO implementation and outreach process (Moustakas, 1994; Patton, 2002). The two lead authors identified common themes arising across interviews and analyzed these themes in light in the science of team science literature, in particular, Stokols and colleagues' typology of contextual factors influencing transdisciplinary scientific collaboration (Stokols et al. 2008b).

RESULTS AND DISCUSSION

There was a great deal of commonality among responses even though each individual librarian tended to draw on themes related to his or her specific role and degree of responsibility on the VIVO project. In order to determine the skills needed for successful teamwork, the lead authors first identified a set of contextual factors affecting the dynamics of the team interaction and performance. These factors were grouped according to Stokols and colleagues' typology of interpersonal, intrapersonal, organizational, technological, societal/political, and physical environment; they are summarized in Figure 1. In describing their experiences on the VIVO project, participants directly addressed skills required for effective teamwork, both those that they already possessed and those that they gained throughout the course of the project. The authors mapped the required skills highlighted by participants, as well as those addressed in the science of team science literature, to the contextual factors affecting the VIVO team's effectiveness.

Intrapersonal Factors

Intrapersonal factors are those pertaining to internal motivations and individual attitudes; those that most affected the VIVO project were team members' attitudes toward collaboration and toward the project itself. Throughout the course of the project, attitudes fluctuated based on day-to-day frustrations and successes, but, overall, team members' attitudes about the project and collaboration were influenced by opportunities for professional development, a perceived enthusiasm towards the project from the outside community, and opportunities to engage with the wider campus community that arose through work on the project.

Although the science of team science literature notes that junior faculty members may be discouraged from participation on large-scale collaborative projects because of academia's focus on individual achievement (Bennett et al. 2010), the majority of the faculty members who participated in this study saw their work on the VIVO team as a positive experience within their career trajectory. Working on VIVO offered team members opportunities to present posters and papers at the regional and national levels. The library professionals who participated in this study mentioned that VIVO is a topic that interests people nationally and participation on the project has helped librarians' careers and led to acceptance of proposals at national and regional conferences. Presenting was particularly beneficial to newer librarians who may not yet have other ongoing research ready to present at regional or national levels, allowing team members to expand their networks, meet new colleagues, and participate in continuing education sessions and conferences that they normally would not have an opportunity to attend. This is particularly important when considering that only three of the library professionals who participated in this study are tenured librarians.

One of the most obvious benefits of the project has been the opportunity to engage more directly with the community the library serves and improve the visibility of the library, potentially changing users' perceptions of what the library can do. Part of the University of Florida's outreach efforts for the VIVO project involved team members making brief presentations about VIVO at the department meetings of each faculty group to which they liaise. This gave librarians the opportunity to get out of their offices and talk to people, even groups with which they had not worked closely in the past. Presenting about VIVO also gave librarians at UF an opportunity to present on other library initiatives including an open access publishing fund, institutional repository, and free interlibrary loan service. College- and institute-level research days provided another unique venue for presenting information about VIVO. At these events, librarians presented posters about VIVO alongside faculty and graduate students' posters on their own research, enabling colleague-to-colleague interactions with this subset of patrons (Norton et al. 2010). VIVO is a project that is important to faculty members interested in research collaboration and thus offers a public display of the library's skills in information organization.

Although intrapersonal factors involved in collaborative efforts are generally internalized and attitude-based, one related skill identified in the literature is that of inclusive thinking (Nash et al. 2003). VIVO team members learned to be open to the opportunities and new experiences afforded through the project, and through these experiences they learned more about their institutions' various cultures and priorities and became more comfortable talking to people across the scholarly spectrum.

Interpersonal Factors

Interpersonal factors address the interactions among team members – their ability to communicate, to learn together, and, ultimately, to work jointly to complete the team's goals. The VIVO team faced the typical challenges of communicating and coordinating across a group with diverse backgrounds. Given these and other tests, collaboration was enhanced through the team's sense of unity in the face of common challenges as well as a perceived potential for future collaboration among team members.

The literature on multidisciplinary teams highlights the significance of paying appropriate attention to overcoming disciplinary differences. The diversity of members' disciplinary backgrounds was a challenge on the VIVO team, with differences in jargon, project management experience and approach, expectations, and conflict resolution styles. The VIVO team was primarily composed of librarians and information technology (IT) specialists, and as such has been a good example of librarians and IT staff coordinating on a deeper level than typically happens in day-to-day institution-level activities. Regular meetings between developers and librarians helped librarians become familiar with the technical terminology related to the project; as this familiarity grew, librarians grew less intimidated by technical aspects of the project and were more likely to engage with developers and ask for clarification when necessary. Differences existed not only in how librarians discussed the software itself but also how librarians described their work processes. Several library professionals mentioned, by way of example, an incident in which librarians were invited to a training session on how to enter data into VIVO; while many librarians assumed this meant receiving a finalized set of instructions, the training instead primarily addressed troubleshooting and discovering problems with the data-entry process.

Working on such a large, diverse team was a beneficial learning experience for many team members. As the team spent time working together, it became more efficient, developing trust and uniting against common challenges. The project also offered the opportunity to develop connections on the national level with team members at partner institutions and with others who have a strong interest in the project. Those who attended the First and Second

Annual VIVO Conferences noted their value in generating interest and excitement about the project at the national level. These conferences and the coinciding one-year and two-year team meeting for the grant-funded project allowed librarians to make strong connections with others on the national VIVO team which has, in some cases, led to other presentations and opportunities to work together.

Two skills required for improving interpersonal aspects of team collaboration on VIVO were communication and perseverance in overcoming obstacles. The science of team science literature abounds with discussion of the importance of strong communication and interpersonal skills in establishing effective collaborative working relationships (Nash et al. 2003, Burke et al. 2006, Bennett et al. 2010). In particular, the library team learned the importance of talking openly as a group, using every possible communication channel (from phone calls and emails to teleconferencing and wikis), and being empathetic when navigating cross-disciplinary conversations. Participants learned that ensuring each team member's understanding increases the chance they will contribute input and help with problem solving, thus strengthening the end product.

Organizational Factors

Organizational factors include the influences of each team member's institution as well as the make-up and organization of the team itself. In the case of the VIVO project, participants most frequently mentioned the changing nature of the project (including changes in personnel) and lack of leadership training for team leaders as organizational impacts on the collaborative effort.

The NIH-funded VIVO project underwent a number of changes throughout its lifetime, from shifts in team members' roles and responsibilities to changes in the team's composition to modifications of project goals and expectations. Some changes in personnel were based on the time-limited nature of the project and pressure on team members to find permanent jobs. In response, team leaders needed to be agile in order to meet changing position requirements and help people gain new skills. Additionally, those in leadership roles learned how to hire individuals with the right skill sets for each position as well as individuals who are adept at handling change in the work environment. As the project developed, goals shifted; however, some team members struggled to keep up with these fluctuating goals, especially when the changes in direction were not clearly articulated. Librarians in leadership positions learned that changing expectations need to be communicated as clearly and quickly as possible so that the team is not working under previous assumptions.

Team leaders on the VIVO project had varying levels of experience in leadership roles and also with working on a project of this magnitude. As such, it would have been beneficial for those in leadership positions to participate in more direct leadership and project management training either prior to or during the course of the project. This type of training would have been especially beneficial given the short-term nature (two years of NIH funding) of this project. Lack of previous large-scale project experience was not limited to team leaders; although the libraries offered enthusiasm and interest, there was little previous experience with this kind of project, making it difficult to know what to expect and how to prepare. The team's challenges in being underprepared for cross-disciplinary work are congruous with Cummings and Kiesler's assertion that previous cross-disciplinary project experience predicts greater strength of a current collaborative work tie (Cummings and Kiesler 2008).

The most important skills that were identified in relation to organizational factors were willingness and ability to adapt and leadership skills. Because teamwork, particularly interdisciplinary teamwork, requires working with diverse team members in ways that may not be familiar or comfortable, the ability to adapt to new and changing circumstances is key

to team effectiveness. As Burke and colleagues describe it, team adaptation is necessary in order for innovation to occur, for the team to collectively test assumptions and gain knowledge, and for new routines and error-correcting strategies to arise (Burke et al. 2006). Although many members of the VIVO team were initially uncomfortable with the changing nature of the project, they developed adaptability skills. Library-based team members have become adept at adapting work plans due to the quickly-changing nature of the technology and the aggressive software development timeline. Leadership skills in communication, effective decision-making, and project management are equally important. Throughout the course of the project, VIVO leaders learned to better discern who would be the right person for each job in the hiring process, to be more efficient in decision making, and to face the project with a more task-driven orientation focused on a concrete action plan.

Technological Factors

The main technological factor discussed by participants as affecting the VIVO team was technological readiness among team members. VIVO is a semantic web tool which members of the VIVO outreach team needed to be able explain to patrons, yet many librarian team members knew little about the semantic web before beginning work on the project. Librarians rose to the challenge of learning semantic web basics, both by reading up on the subject and by asking questions of other project members with more experience. For those involved in implementation as well as outreach, it was also necessary to learn technical information and skills related to system architecture and data management. This type of project requires an aptitude for technology but not comprehensive knowledge about every technical aspect. For some librarians, this has translated into an acceptance of some level of comfort with only basic high-level details of the technology while developing the ability to identify what is needed in order to get up to speed. In addressing a lack of technological readiness, VIVO team members again needed to demonstrate their willingness and ability to adapt to change and learn new things. Team members saw this aspect of learning as a major benefit to working on the project.

Societal/Political Factors

Societal and political factors affecting collaboration were not a major focus of interviews, although participants did mention the challenges associated with working at relatively decentralized institutions.

Physical Environmental Factors

The spatial distribution of team members is listed among the physical and environmental factors influencing cross-disciplinary collaboration (Stokols et al. 2008b), and this did affect the work of those VIVO team members with national-level responsibilities on the project. Although the team held an in-person meeting at the beginning of the grant period, working primarily across distance with team members who were not close colleagues before the project was a challenge. VIVO team members' experiences mirrored those described in the science of team science literature with geographically distributed teams: slower relationship building, the need for more intentional coordination, and less spontaneous interaction, which acts as a kind of glue for collaborative relationships among team members (Kraut et al. 2002). As team members mentioned, geographic distance introduces a lack of personal contact, lack of non-verbal clues, and difficulty in determining team members' moods and attitudes. In order to overcome these challenges, team members again had to rely on their communication skills, talking openly and using multiple avenues of communication whenever possible.

CONCLUSIONS

Although many experiences of VIVO team members were specific to the VIVO project, the participants' comments illuminated a variety of lessons that could be applicable to other librarians engaging in large-scale, cross-institutional, and/or cross-disciplinary collaborations. The skills most important to the VIVO team in handling collaborative challenges were inclusive thinking, strong communication, perseverance in overcoming obstacles, willingness and ability to adapt, and leadership skills. In addition to highlighting required skills, participants' insights led to the following recommendations:

- Large-scale cross-disciplinary projects will involve technology, especially communication or collaboration technologies that are used to help facilitate group-level work, even if they are not as technologically focused as the VIVO project. Librarians should prepare themselves for technical aspects of the project as much as possible ahead of time, but keep in mind that technological readiness is not necessarily indicated by an intimate deep technical understanding of the technology; often the willingness to learn and adapt to technology is most important.
- Communication issues will inevitably arise on cross-disciplinary projects. Plan ahead for regular meetings and employ a variety of communication venues (e.g. teleconferencing, wikis, email), while maintaining a willingness to remain flexible and try new approaches.
- Roles and responsibilities for team members should be clearly defined at the outset of the project in order to ensure that everyone on the team meets expectations. When roles, responsibilities, or project goals change, leaders should communicate those changes and accompanying changes in expectations to the team.
- Leaders on cross-disciplinary projects bear great responsibilities, both in terms of motivating the team and in ensuring task and project completion. Every effort should be made to provide them as much training and preparation in leadership and project management as possible before the beginning of the project.
- As scientists recognize librarians as their partners in the research process, it becomes vital for librarians to adapt to potentially different teamwork styles. Although librarians can be naturally conflict averse (Martin 2006), some conflict is inevitable in large collaborative projects and must be addressed to ensure team effectiveness. Positive conflict in the form of differences of opinion can also benefit teams as it can generate new, creative ideas.

Librarians and libraries, with their multidisciplinary focus and neutral position on many campuses, are ideal partners for a variety of cross-disciplinary collaborative efforts. Across the VIVO project institutions, work empowered team members to subsequently move on to work on other cross-disciplinary collaborations, including a research data assessment and data management training with high performance computing experts, textbook authorship with medical educators, provision of patient education services with health literacy and medical specialists, and efforts to better understand and assess research impact (Sarli and Holmes 2011), among other initiatives. Cross-disciplinary collaborations are valuable opportunities for librarians to demonstrate the value of library information professionals to faculty colleagues in other disciplines and to join patrons more fully in their research projects.

Acknowledgments

This project was made possible through funding from the NIH: "VIVO-Enabling National Networking of Scientists" National Institutes of Health, U24 RR029822.

References

- Aitken E, Powelson SE, Reaume RD, Ghali WA. Involving clinical librarians at the point of care: results of a controlled intervention. *Academic Medicine*. 2011; 86(12):1508–1512. Retrieved September 27, 2012 from <http://www.ncbi.nlm.nih.gov/pubmed/22030761>. [PubMed: 22030761]
- Bandy M, Condon J, Graves E. Participating in communities of practice. *Medical Reference Services Quarterly*. 2008; 27(4):441–9. Retrieved May 2, 2012, from <http://www.tandfonline.com/doi/pdf/10.1080/02763860802368316>. [PubMed: 19042723]
- Bennett, ML.; Gadlin, H.; Levine-Findley, S. Team science and collaboration: a field guide. Bethesda, MD: Department of Health and Human Services; 2010. Retrieved September 27, 2010 from https://ccrod.cancer.gov/confluence/download/attachments/47284665/TeamScience_FieldGuide.pdf
- Börner K, Contractor N, Falk-Krzesinski HJ, Fiore SM, Hall KL, Keyton J, Spring B, Stokols D, Trochim W, Uzzi B. A multi-level systems perspective for the science of team science. *Science Translational Medicine*. 2010; 15(2):49cm24. Retrieved September 27, 2012 from <http://stm.sciencemag.org/content/2/49/49cm24.full.pdf>.
- Burke CS, Stagl KC, Salas E, Pierce L, Kendall D. Understanding Team Adaptation: A Conceptual Analysis and Model. *Journal of Applied Psychology*. 2006; 91(6):1189–1207. Retrieved May 9, 2012, from <http://psycnet.apa.org/journals/apl/91/6/1189.pdf>. [PubMed: 17100478]
- Cummings, JN.; Kiesler, S. Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research. *Proceedings of the ACM; 2008 Conference on Computer Supported Cooperative Work*; San Diego, CA. 2008. p. 437-446. Retrieved May 7, 2012 from <http://www.cs.cmu.edu/~kiesler/publications/2008pdfs/2008Cummings-Kiesler.pdf>
- Davis, V.; Devare, M.; Russell Gonzalez, S.; Tennant, MR. Implementation of a new research discovery tool by the university libraries at Cornell University and the University of Florida. *Biomedical and Life Sciences Division contributed papers session, Special Libraries Association Annual Conference*; Washington DC. 2009.
- Disis ML, Slattery JT. The road we must take: multidisciplinary team science. *Science Translational Medicine*. 2010; 2(22):22cm9. Retrieved August 14, 2012 from <http://stm.sciencemag.org/content/2/22/22cm9.full>.
- Dudden RF, Protzko SL. The systematic review team: contributions of the health sciences librarian. *Medical Reference Services Quarterly*. 2011; 30(3):301–315. Retrieved May 7, 2012, from <http://www.tandfonline.com/doi/pdf/10.1080/02763869.2011.590425>. [PubMed: 21800987]
- Fiore SM. Interdisciplinarity as teamwork: how the science of teams can inform team science. *Small Group Research*. 2008; 39(3):251–277. Retrieved May 2, 2012 from <http://sgr.sagepub.com/content/39/3/251.full.pdf>.
- Glenn E, Rolland B. Librarians in biomedical research: new roles and opportunities. *Information Outlook*. 2010; 14(7):26–29. Retrieve May 6, 2012 from <http://students.washington.edu/brolland/Research/SLA%20Outlook%20Final%20Article.pdf>.
- Gold A. Cyberinfrastructure, data, and libraries, part 2. *D-Lib Magazine*. 2007; 13(9/10) Retrieved May 30, 2012 from <http://www.dlib.org/dlib/september07/gold/09gold-pt2.html>.
- Holmes KL, Dubinsky EK. Integration of Web 2.0 technologies in the translational research environment. *Medical Reference Services Quarterly*. 2009; 28(4):309–35. Retrieved May 2, 2012, from <http://www.tandfonline.com/doi/pdf/10.1080/02763860903249027>. [PubMed: 20183032]
- Holmes, KL.; Tennant, MR.; Hack, G.; Davis, V.; Devare, MH.; Russell-Gonzalez, S.; Conlon, M. VIVO Collaboration. VIVO: a national resource discovery tool for the biomedical community. Contributed paper, *Biomedical and Life Sciences Division Contributed Papers Session*. Special Libraries Association Annual Conference; New Orleans, LA. June 2010; 2010. Retrieved May 2, 2012, from http://units.sla.org/division/dbio/events/conf_current/papers/VIVO_SLA_Holmes.pdf

- Huerta D, McMillan V. Reflections on collaborative teaching of science information literacy and science writing. *Resource Sharing & Information Networks*. 2004; 17(1–2):19–28. Retrieved September 27, 2012 from http://www.tandfonline.com/doi/abs/10.1300/J121v17n01_03.
- Krafft, DB.; Cappadona, NA.; Caruso, B.; Corson-Rikert, J.; Devare, M.; Lowe, BJ. VIVO Collaboration. VIVO: enabling national networking of scientists. *Proceedings of the WebSci10: Extending the Frontiers of Society On-Line*; April 26–27th; Raleigh, NC. 2010. Retrieved May 2, 2012 from http://journal.webscience.org/316/2/websci10_submission_82.pdf
- Kraut, RE.; Fussell, SR.; Brennan, SE.; Siegel, J. Distributed work. Cambridge, MA: MIT Press; 2002. Understanding effects of proximity on collaboration: Implications for technologies to support remote collaborative work; p. 137–162. Retrieved May 30, 2012 from <http://www.psychology.sunysb.edu/sbrennan-/papers/kraut.pdf>
- Lounsbury JW, Foster N, Patel H, Carmody P, Gibson LW, Stairs DR. An investigation of the personality traits of scientists versus nonscientists and their relationship with career satisfaction. *R&D Management*. 2012; 42(1):47–59.
- Lynch, RP. Collaborative innovation: essential foundation of scientific discovery. In: Ekins, MAZ.; Hupcey, A.; Williams, AJ., editors. *Collaborative Computational Technologies for Biomedical Research*. Hoboken, NJ: John Wiley & Sons, Inc; 2011.
- Martin ER. Team effectiveness in academic medical libraries: a multiple case study. *Journal of the Medical Library Association*. 2006; 94(3):271–278. Retrieved September 27, 2012 from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1525325/>. [PubMed: 16888659]
- Moore M. Teaching physicians to make informed decisions in the face of uncertainty: librarians and informaticians on the health care team. *Academic Medicine*. 2011; 86(11):1345–1345. [PubMed: 22030644]
- Moustakas, C. Phenomenological research methods. Thousand Oaks, CA: Sage Publications; 1994.
- Nash JM, Collins BN, Loughlin SE, Solbrig M, Harvey R, Krishnan-Sarin S, Unger J, Miner C, Rukstalis M, Shenassa E, Dubé C, Spirito A. Training the transdisciplinary scientist: a general framework applied to tobacco use behavior. *Nicotine & Tobacco Research*. 2003; 5(Supplement 1):S41–S53. Retrieved May 7, 2012 from http://ntr.oxfordjournals.org/content/5/Suppl_1/S41.full.pdf. [PubMed: 14668086]
- Norton, HF.; Garcia-Milian, R.; Tennant, MR.; Henning, S.; Conlon, M. VIVO Collaboration. VIVO: researcher networking and discovery across disciplines. Conference poster presented at Florida Genetics 2010: The Sixth Annual Symposium of the UF Genetics Institute; Gainesville, FL. 2010. Retrieved August 14, 2012 from <http://ufdc.ufl.edu/IR00000367/00001>
- Patton, MQ. Qualitative research and evaluation methods. 3. Thousand Oaks, CA: Sage Publications; 2002.
- Pritchard PA. The embedded science librarian: partner in curriculum design and delivery. *Journal of Library Administration*. 2010; 50(4):373–396. Retrieved September 27, 2012 from <http://www.tandfonline.com/doi/abs/10.1080/01930821003667054>.
- Rambo N. E-science and biomedical libraries. *Journal of the Medical Library Association*. 2009; 97(3):159–161. Retrieved May 30, 2012 from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2706433/>. [PubMed: 19626139]
- Rosenfield PL. The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. *Social Science and Medicine*. 1992; 35(11):1343–1357. [PubMed: 1462174]
- Russell-Gonzalez, S.; Davis, V.; Tennant, MR.; Holmes, KL.; Conlon, M. VIVO Collaboration. Letting the good times roll through alignment: meeting institutional missions and goals with VIVO, a web-based research discovery tool. *Biomedical and Life Sciences Division Contributed Papers Session; Special Libraries Association Annual Conference*; New Orleans, LA. 2010. Retrieved May 2, 2012 from http://www.sla.org/PDFs/Conf/SLA_VIVO_Contributed_Paper.pdf
- Sarli, CC.; Holmes, KL. Assessing the impact of research: a Bernard Becker Medical Library project. *Bernard Becker Medical Library*; 2011. web site. Retrieved August 14, 2012 from <https://becker.wustl.edu/impact-assessment>
- Stokols D, Hall KL, Taylor BD, Moser RP. The science of team science: overview of the field and introduction to the supplement. *American Journal of Preventive Medicine*. 2008a; 35(2S):S77–

S89. Retrieved May 2, 2012 from http://ac.els-cdn.com/S074937970800408X/1-s2.0-S074937970800408X-main.pdf?_tid=b674aac9ee64e90bb2016668d657253d&acdnat=1335981002_db77c2868ca1534a2e6672b8a4ed550f. [PubMed: 18619407]

Stokols D, Mistra S, Moser RP, Hall KL, Taylor BK. The ecology of team science: understanding contextual influences on transdisciplinary collaboration. *American Journal of Preventive Medicine*. 2008b; 35(2S):S96–S115. [PubMed: 18619410]

Urquhart C, Turner J, Durbin J, Ryan J. Changes in information behavior in clinical teams after introduction of a clinical librarian service. *Journal of the Medical Library Association*. 2007; 1(95):14–22. [PubMed: 17252062]

VIVO-National Networking of Scientists. National Institutes of Health; 2009. U24 RR029822. <http://www.vivoweb.org>

Figure 1.

Summary of Contextual Factors Influencing Collaborative Effectiveness of VIVO Team Members based on model by Stokols and colleagues (Stokols et al, 2008b).