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Team Science: Development of an immersive curriculum for information professionals to play an expanding role in scientific collaboration.

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Development of an Immersive Curriculum for Information Professionals to Play an Expanding Role in Scientific Collaboration

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ABSTRACT

Team science addresses scientific challenges through collaboration among scientists from varied domains and expertise. This kind of collaboration presents challenges related to team communication and data sharing. This paper presents the Team Science initiative that focused on preparing information professionals to function efficiently in the team science environment. It provides the framework for the curriculum, the lessons learned from the experiential learning approach to student engagement, and discusses the outcomes from the first cohort of students. The paper also offers lessons learned which can be used as a road map by other schools to develop a team science curriculum.

TOPICS

Data curation; Curriculum; Specific populations; Team Science; Experiential learning

INTRODUCTION

Team science has been defined as "a collaborative effort to address a scientific challenge that leverages the strengths and expertise of professionals trained in different fields" (NCI, 2012). From the development of the atomic bomb, to the mapping of the human genome, to dealing with complex issues related to climate change and sustainable development, cross-disciplinary scientific teams have applied multiple perspectives and areas of expertise to solving complex problems and addressing scientific challenges (Fiore, 2008; Ledford, 2015).

The conduct of successful team science research has challenges, many of those related to team collaboration and sharing of scientific information (NRC, 2015). Researchers from diverse disciplinary backgrounds often have different vocabularies, research methods, and ways of conceptualizing a scientific problem (Edwards et al., 2011; Ledford, 2015; Stokols et al., 2008). Teams that are not co-located may struggle to share data and information across geographic boundaries (NRC, 2015; Stokols et al., 2008). Further, team science research involves the creation and integration of diverse scientific data sets, often on a very large scale. While good management of this data is essential for successful team science collaboration, scientists' actual data management practices are often inadequate, particularly for the sharing of data across

disciplinary boundaries (Edwards et al., 2011; NRC, 2015; Wolkovich, Regetz, & O'Connor, 2012).

Information professionals naturally fit into many roles in supporting cross-disciplinary, data-driven science and are beginning to be seen as valuable "embedded" members of scientific teams (Federer, 2016; García-Milian et al., 2013; Janke & Rush, 2014; Lyon, 2016). One of these roles is data management and curation. The information professional's unique skills allow her to provide valuable assistance in answering questions such as: how can we assure that new findings are effectively shared, stored, and preserved, particularly among researchers who are facing geographical, subject discipline, and even linguistic boundaries? Who should be in charge of managing information and data resources? How can we ensure that our role in the management of scientific data is recognized and accepted by the research community?

Multiple factors can negatively impact scientific teams, including domain scientists' habits, preconceptions, and lack of familiarity with information scientists' skillsets, and in many cases, information professionals' lack of domain subject knowledge and lack of experience with cross-disciplinary teamwork, scientific workflows, and work environments (García-Milian et al., 2013; Lorenzetti & Rutherford, 2012; Lyon, 2016; Shumaker, 2012). Ultimately, there is still a tendency for librarians and other information professionals to be perceived not as integral team players in scientific research, but as passive observers offering only remote support to data-driven science (Lyon, 2009).

TEAM SCIENCE

Team Science (Data Specialists Enabling Team Science), an information science curriculum initiative, was designed to educate students to become integral members of research teams and to anticipate the data and information needs of researchers, expanding the traditional role of responding to requests for data and information services. The University of Tennessee (UT) was uniquely positioned to lead this effort for two reasons: (1) involvement in the NSF-funded DataONE project (www.dataone.org), a large-scale effort to ensure the preservation, access, use, and reuse of multi-scale, multi-discipline, and multi-national science data, and (2) relationships with a variety of science-intensive agencies such as Oak Ridge National Laboratory. The first cohort of students was admitted to UT in August 2014.

The strong relationships between UT's communication and information disciplines was essential in helping students acquire the skills necessary to negotiate diverse, distributed teams and the expertise to manage the entire research and data lifecycles, from planning through preservation to analysis, and to effectively work with interdisciplinary teams of researchers. The goals of the Team Science program are to provide students with the skills they need so they can:

- Become integral members of research teams throughout projects
- Anticipate the data, information and communication needs of researchers
- Play active roles in research teams
- Transcend traditional approach of waiting to respond to requests for data and information services
- Work as information professionals on large-scale scientific teams

Recruitment. The first Team Science cohort consisted of six IMLS-funded students, three women and three men. These students were chosen to represent the diversity of paradigms one might find on a science team including a computer scientist, a microbiologist, a marine biologist, a geographer, a chemist, and a philosopher. These students represented both disciplinary diversity and diversity in the traditional sense in terms of gender and socioeconomic status (SES). In addition, the cohort had peer mentors of an advanced master's student (chemistry) and a doctoral student.

Lessons learned: While a tight April-July recruitment timeframe may have limited the success of outreach to underserved populations, we were successful in recruiting a diverse cohort and the cohort benefitted from this diversity. Having a humanities scholar with an interest in science and a range of sciences enriched participants' experience since they often learned from the different perspectives of their colleagues.

Curriculum. The Team Science curriculum focused on three core aspects of information professionals' roles. Each of these was a unique area of expertise which was essential for being successful in the team science environment.

(1) **Data management and curation**: Students learned how to preserve data, and also how to advise and assist researchers on data management issues during research planning, data gathering, and dissemination (Foster et al., 2010).

(2) **Communication**: García-Milian et al. (2013) identified five main skills required of information professionals as they engage in cross-disciplinary, multi-institutional team projects: Strong communication skills, willingness to adapt, perseverance in overcoming obstacles, leadership, and inclusive thinking.

(3) **Situational knowledge**: Situational knowledge is knowledge gained from experience. It is often summarized as "We discover what we know from our world." For Team Science, situational knowledge refers to understanding how scientists use information and communicate with one another as well as domain-specific knowledge.

Courses in the Team Science curriculum emphasized skills in all three areas of expertise. (See Table 1.) The program of study included two communication courses outside of the School of Information Sciences (SIS): Organizational & Team Communication and Mindfulness. Courses in bold were required of all students. The rest of the students' schedules were tailored to each individual to help them achieve their own professional goals.

Lessons learned: Designing for flexibility allows for adjustments to externalities (such as a course not being offered in a particular semester) as well as adjustments to best meet individual student needs and learning styles. Preparation for being a team science-enabling professional may or may not focus on data. Requiring courses across disciplines can be challenging, but rewarding.

Table 1. Courses in the Team Science Curriculum

AREA OF EXPERTISE	SKILLS	COURSES
Data Management and Curation	• Data lifecycle knowledge • Information/Data consulting • Information/Data leadership • Metadata knowledge • Ability to work with range of data types • Confidence as information expert (knowledge of information seeking behaviors; ability to provide information support)	• **Environmental Informatics** • Digital Curation • Information Network Applications • Information Architecture • Geographic Information • Geospatial Technologies • Human Computer Interaction • Collection Development
Communication	• Speak with experts • Write for experts • Learn from experts • Understand organizational context	• **STEM Communication and Information** • **Organizational & Team Communication** • **Mindfulness** • Scientific and Technical Communication • Social Media, Technology and Society
Situational Knowledge	• Observe environmental context • Interact in unfamiliar environment • Manage ambiguity • Express creativity • Provide information delivery and management	• Federal Libraries and Info Centers • Sources and Services for Science & Engineering • Academic Libraries • Sources and Services for the Humanities • ePublication • Management of Information Organizations • Web Development • Research Methods

Immersive education and research opportunities. Student preparation included an immersive experience in an information intensive science environment including these organizations: Oak Ridge National Laboratory (ORNL), which is the Department of Energy (DOE)'s largest science and energy laboratory; the Office of Scientific and Technical Information (OSTI), which leads the DOE's e-government initiatives for disseminating R&D information; and the United States Geological Survey (USGS), a federal science organization that provides information on ecosystems and the environment. In addition, the students traveled to New Mexico to visit the Los Alamos National Laboratory (LANL), Sandia National

Laboratories, the Santa Fe Institute, the University of New Mexico Libraries, a leader in eScience initiatives, and the DataONE offices, where they spoke with over 40 scientists, librarians and other professionals engaged in team science.

Additionally, students regularly met as a cohort and worked together as a team on two professional presentations and on a project developing a proof of concept for a tool that would enable the UT Office of Research and Engagement (ORE) to identify team members for interdisciplinary STEM (science, technology, engineering and mathematics) projects. These experiences expanded the team science curriculum from providing an opportunity to study interdisciplinary teams to providing the experience of being *in* an interdisciplinary team and working together to achieve common goals.

Lessons learned. While these activities required substantial planning, they also provided value to the program that made them worth the effort, including the ability to directly interact and learn from practicing professionals and researchers in multiple fields.

CONCLUSION

All students in the initial cohort successfully completed the program and graduated with a Master's degree in Information Science. Most have since been successfully placed in positions that will allow them to work as members of research teams. Development of the team science curriculum continues at UT and plans are underway to introduce a team science pathway to the SIS program. The success of the Team Science program was a result of many factors including successful recruitment of a diverse cohort of students, the development of a flexible, interdisciplinary curriculum that enabled students to build core skills essential for data management and for working as members of cross-disciplinary teams, and the ability to forge and leverage relationships with other departments and other organizations in order to provide students with a fully immersive experience that enabled them to work as an interdisciplinary team, to participate in research projects, and to learn from and be mentored by professionals working in team science. Schools interested in developing a team science program of their own should consider how they might leverage their own resources to provide an immersive, interdisciplinary experience for information science students.

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