Current Use and Prospective Future of the University Map Library: A Case Study of Multiple Perspectives From One Institution

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There's a big difference when you can actually see the history and you can touch it; it makes learning that much more enriching. You can come into the map library any time and examine any map you want. When you come to university you don't realize how many learning opportunities there are, but this is a great resource.

Mack Gilles
McMaster University undergraduate student

As both a repository of cartographic information and a source of human guidance for the use of such material, map libraries in academic institutions have a long tradition of preserving, transferring, and facilitating access to a wide array of knowledge. From special collections of historically significant rare maps to assemblages of modern topographic sheets, plans, and aerial photographs, map libraries offer researchers, students, and members of the public an opportunity to better understand human and natural environments of the past and present.

As with much of the broader academic library, the goals and day-to-day operations of the current-day map library are influenced by myriad organizational and discipline-related factors: pressure for space on academic campuses and budgetary constraints influence curators' decisions on collection development; digitization programs and born-digital data have transformed the ways in which information is provided to users and broadened audiences, but also require new systems, skills, and personnel to support them; and growing interest in geospatial data and Geographic Information Systems (GIS) beyond traditional geography-related disciplines has created a service need within the academic institution. The confluence of these influences (along with many others unmentioned

here) provides the canvas upon which the course of the modern map library may be plotted.

To describe, contextualize, and understand the changing role of the modern map library, this paper compiles the personal narratives of several users of a single collection—the Lloyd Reeds Map Collection in the McMaster University Library. While the perspectives provided in this study convey only a sample of the diverse commentary on this subject, they provide an opportunity to explore the varied experiences with (and conceptualizations of) a single map library among individuals of differing academic backgrounds and career stages, who have varying expectations for support and guidance. To highlight this diversity, contributor reflections are presented in their entirety, and their general themes are identified and discussed in greater depth. By exposing and synthesizing themes from contributed accounts, this paper underscores the broadening role of map libraries in improving spatial literacy across the university.

The McMaster Lloyd Reeds Map Collection

The Lloyd Reeds Map Collection is located in the Mills Memorial Library on McMaster's main campus in Hamilton, Ontario, Canada. Shortly after being founded within the McMaster School of Geography in the early 1960s by Professor Lloyd George Reeds, the Map Collection was transferred to the McMaster Library for stewardship. The collection has continually grown since its inception and today consists of more than 130,000 paper maps, 18,000 aerial photos, and 3,000 atlases. Recent large-scale digitization efforts within the library have made close to 10,000 of the collection's historical maps, plans, and aerial photos freely available online through the library's Digital Archive.[1]

Beyond making the physical and digital collections available to all campus groups, the library professionals within the Map Collection provide guidance on searching for geospatial datasets, as well as on the use of GIS and other specialized cartographic and statistical software for research or teaching purposes. Map Collection staff also offer pedagogical support for various labs and courses, including guest lectures and assessment design. To facilitate its integration with teaching and learning, the collection has its own flexible classroom with a SmartBoard that seats up to 40 people, but converts to a study area when not in use (figure 1).

The recent creation of online modules (figure 2) represents a major undertaking by Map Collection staff to provide spatial literacy instruction to undergraduate students (Maclachlan et al. 2014; Vine et al. 2016). The purpose of this initiative was to bring added value to geography and other disciplines by improving student spatial literacy, while also addressing an increasing demand for spatial literacy lectures by the Map Collection library professionals, which

[1] https://library.mcmaster.ca/maps/.

Fig. 1. *Floor plan for the the McMaster Lloyd Reeds Map Collection, March 2017. Image courtesy of Gordon Beck.*

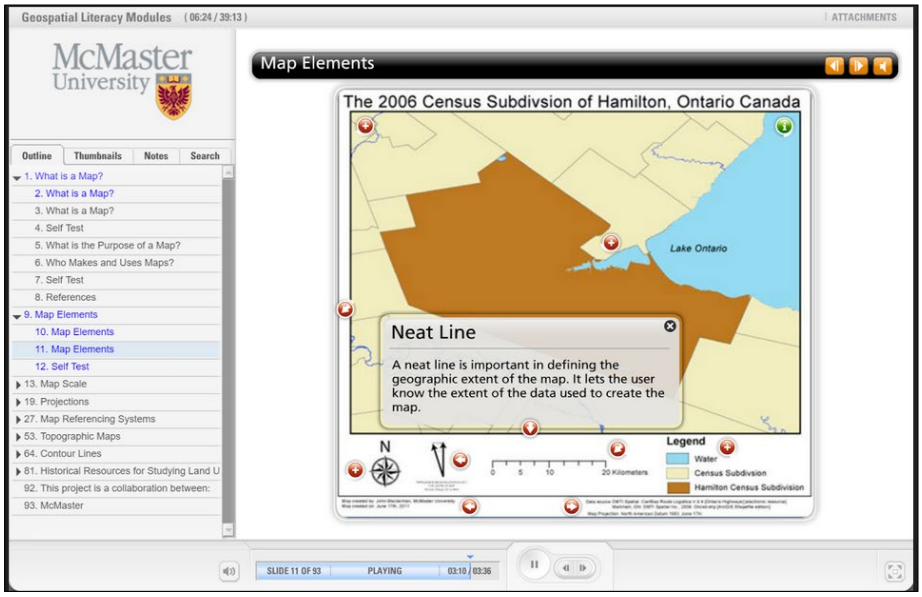

Fig. 2. *Screenshot of spatial literacy modules created by library professionals in the Map Collection for use by students, staff, and faculty*

was unmanageable with current staff resources. The online modules cover numerous aspects of spatial literacy (from map elements to projections), while allowing students to learn at their preferred pace and on their own time. Student feedback on the modules has been extremely positive (Vine et al. 2016), and staff time has been freed to answer the higher level research and pedagogical questions that often stem from student on-demand learning (Maclachlan et al. 2014).

Spatial Literacies in Multiple Disciplines

"The term spatial literacy is rarely explicitly described; rather it is more often discussed with reference to spatial abilities and spatial thinking" (Jarvis 2011, 294). Evidence supports the theory that individuals have a baseline of innate spatial understanding and ability, and that spatial skills must be actively encouraged and practiced to promote student development (Jarvis, 2011). A comprehensive definition by Bednarz and Kemp (2011) describes spatial literacy as the ability of an individual to "capture and communicate knowledge in the form of a map, understand and recognize the world as viewed from above, recognize and interpret patterns, know that geography is more than just a list of places on the Earth's surface, see the value of geography as a basis for organizing and discovering information, and comprehend such basic concepts as scale and spatial resolution" (19).

In the following narrative, Jason Brodeur illustrates the diversity of requests, academic backgrounds, and expertise of those requesting geospatial data and support, and highlights the challenges associated with providing spatial literacy across a university campus. As such, those working within the field of map collection must be experts in the specific disciplines of the spatial sciences (e.g., cartography, GIS, spatial statistics) to properly facilitate discussion and improve research and education goals on campus.

Narrative #1—The Perspective of the Library Professional

Jason Brodeur, Manager, Maps, Data, GIS, McMaster University Library

The McMaster University Library provides broad support for the varied GIS-related needs of students, staff, and faculty members in their research and learning. Generally, users' requirements are addressed through a number of supporting activities, which include providing training and guidance in the use of GIS software; developing finding aids and assisting with searches for geospatial data and consulting on its appropriate use; and providing access to restricted or licensed data sets by negotiating terms of use with data providers and purchasing licenses, where required. Given the heterogeneity of potential users across the campus, providing the aforementioned resources and services in an effective, efficient, scalable, and sustainable manner presents manifold challenges that require a variety of solutions.

A significant challenge that I face is the degree to which users vary in their understanding of, and experience and skill with, GIS software and geospatial data. While uninitiated users typically seek general information and training with software and data, experienced users commonly require specific information on data or analytical processes to inform their methodological decisions. Beyond this, users also have diverse disciplinary backgrounds and interests in using GIS approaches, which leads to variation in the types of data being sought, as well as in requirements for data processing and dissemination. For example, those applying Historical GIS (HGIS) approaches often require support with georeferencing images, building datasets, and visualizing results, while those evaluating quantitative hypotheses—for logistical and remotely sensed imagery analyses, for example—more commonly seek guidance on topics relating to data access and quality, as well as on methodological approaches. We address this diversity in users' knowledge, experiences, and interests by taking a broad and flexible approach in training and consultation. For example, we compile and disseminate information for a wide array of geospatial data, recommend software and methodological approaches according to specific needs, and tailor training resources to the users' background and aspirations. In many cases, we develop recommendations through a reference interview, which consists of a combination of exploratory discussion and targeted questions.

Another persistent challenge relates to users' ability to find, access, understand, and use the data they need for their work. While consultation is typically the best approach for connecting users to data, such an approach is not scalable to the entire population of potential users at the university. Furthermore, it is a reasonable assumption that many users are unaware of where to look for geospatial data for their projects or whom to ask for guidance with this process. Anecdotal evidence supports this hypothesis, as the exclamation "I had no idea this resource/service/data existed" is common during first-time consultations. For users with no prior knowledge of prominent geospatial data sources or the library's services, it is probable that web searches are the first (and perhaps only) method of inquiry. In such cases, it is critical

that searches result in discovery of the most appropriate information. To address these requirements, the library leverages the power of the semantic web by providing thorough and structured metadata for a wide range of geospatial data through web crawler-exposed web pages. The goal of this approach is to maximize the likelihood that the user finds the data they need or at least is aware of the library as a source of information and guidance.

The importance of spatial literacy instruction in higher education has been emphasized in recent years as it is perceived to be a valuable skill for employment (Tsou and Yanow 2010), and because of a proliferation of geospatial data and easy-to-use viewing and analysis software, such as Google Earth (Bednarz and Kemp 2011; King 2006; Maclachlan et al. 2014; Newcombe 2006; Youngblood 2006). The ubiquity of geospatial data and expectation for their use in diverse applications requires both academic and private sector professionals to have a practical understanding of spatial literacy concepts in order to effectively communicate their work to each other and the general public (Kim 2011). As such, interest has broadened for spatial skill and knowledge development outside of traditional disciplines.

The following narrative comes from engineering professor Brian Baetz who, through the expertise of the Map Collection staff, introduces not only concepts of spatial literacy but the technology used in creating and interpreting the data. The class is taught in an experiential fashion with students spending most of their time working with the data.

Narrative #2—GIS and Spatial Literacy to Build Students' "Tool Kits" in Civil Engineering Instruction

Brian Baetz, Professor, Civil Engineering, Faculty of Engineering
McMaster University

Through the introduction of QGIS[2] fundamentals and applications into a third-year core civil engineering systems course and a coursework master's core course in systems engineering and public policy, I have been fortunate to have my students exposed to GIS concepts and practices. For both courses, after an hour of introductory material, the students plunge into the creation of three maps based on hypothetical but representative situations from municipal engineering practice. Library professionals very capably introduce this material and adroitly guide the students to the successful completion of the three mapping modules and also make themselves available for student questions on GIS software and dataset availability as the students use GIS in downstream courses and project research.

The most significant challenges associated with the introduction of GIS into these two courses have been the lack of background these engineering students have in GIS fundamental concepts (and even cartography fundamentals, a lack of working knowledge of the QGIS software, and the potentially limited availability of data for downstream

[2] QGIS (Quantum Geographic Information System) is a free and open-source software

courses and project research. The most significant benefits arising from the introduction of QGIS into the courses have been the expansion of the students' professional "tool kits" (particularly for communicating and illustrating spatial results from other optimization or simulation-based tools) and the development of an awareness of the potential power of GIS and its tremendously useful application in future research and professional practice.

As mentioned earlier, the library professionals' role in this integration of GIS into two engineering courses has been at the instructional level and at a technology resource expert level (providing details of software use, and addressing follow-up questions from students on downstream integration of GIS into other courses and research, and identification of possible sources of data). The implementation of this role—as technology expert and information resource specialist—was particularly effective because of the professional staff's enthusiasm and their ability to help solve software problems on the run within a group of demanding students.

A series of video modules was prepared by the library professionals and loaded up on the cloud for students to view anywhere and anytime. This greatly reduced the number of questions that needed to be answered. As engineers are always interested in practical applications of software tools, a suggested improvement could be the provision of "real world" case studies of GIS application to municipal infrastructure, transportation systems, and environmental systems problems.

In summary, the introduction and integration of GIS into these two engineering courses has been very fruitful and has generated considerable positive feedback from the student cohorts over the last five years.

Using Spatial Data for Interdisciplinary Studies

It is not a new idea to incorporate spatial information into disciplines traditionally considered part of the humanities and social sciences. For centuries, society has understood that location and spatial patterns of resources and markets can influence planning in commerce and politics (Goodchild and Janelle 2010). For example, the first works relating space and health in the mid-nineteenth century (e.g., Snow 1855) initiated the field of epidemiology and has led to the modern-day use of maps to inform public discussion and policy (e.g., Maclachlan et al. 2007). In the humanities, efforts have been made to document the role of place in society through the Electronic Cultural Atlas[3] and the value of the spatial perspective in the Spatial History Project at Stanford University.[4] In general, there is a trend toward the inclusion of spatial understanding in the humanities and social sciences (Gregory and Geddes 2014; Okabe 2016).

[3] http://www.ecai.org/

[4] http://web.stanford.edu/group/spatialhistory/cgi-bin/site/index.php

The following narrative is by John Maclachlan, an instructor in the McMaster University Arts and Science Program.[5] The vast majority of Arts and Science students have had either limited or no experience with spatial data and technologies.

Narrative #3—Spatial Literacy Instruction in Non-Traditional Programs

John Maclachlan, Instructor, Arts and Science Program
McMaster University

As an instructor in the McMaster University Arts and Science Program, I have the opportunity to work with students from various academic disciplines. The program is designed to provide students with interdisciplinary educational experiences, with substantial training in fields thought traditionally to be both in the arts and the sciences. Within this program, there are numerous courses that are meant to offer students similar skill-building opportunities, but have a course theme that varies with each instructor. Once such course is Society and Technology II, which explores the impact of technology on society; when I had the opportunity to instruct this course, it revolved around spatial data and decision making.

The diversity of disciplinary backgrounds of the 30 students in this course meant that it was important to have the data necessary for course success available in an academically neutral area, such as the McMaster Map Collection located within the library. Additionally, students in the class had varying experience with both geospatial literacy and geospatial data, so face-to-face time was used to explore the importance of spatial information throughout history. Having the geospatial data located in one area, coupled with the expertise of the library professionals at the McMaster Map Collection, allowed student access to expertise into all aspects of geospatial literacy, from the understanding of historical maps through modern census data. This ensured that the students had a wide range of opportunities to interact with data. Students interacted with the collections in the map library throughout the second-semester projects, which offered unique methods to disseminate their findings.

The Arts and Science 3BB3—Rare Maps Exhibit 2016 was created to explore and promote some of the interesting rare maps in the Map Collection. Students were assigned an archived rare map (typically from the 1500s–1800s); they were asked to create the metadata necessary for map identification and to research an aspect of the map that interested them. Each student had the opportunity to display their work publicly in an effort to help others better understand how cartography has evolved and the importance of understanding the maps that existed before Google Earth (figure 3). Having access to the rare maps and the staff's expertise helped students explore the maps' significance and digitization. The opportunity for students to disseminate their research results made this project valuable to both the students and the general

[5] https://artsci.mcmaster.ca/program/

public. This was a valuable crowdsourcing project where the students had the opportunity to create information that is available for public use.

The second, more ambitious, project was the Collaborative Writing Group (CWG), which aims to incorporate undergraduate research into a course, giving students the opportunity, over an eight-to-ten-week period, to go through the entire research process, from formulating a question to disseminating results. In this course, students are being asked not only to create within a few weeks a research project that is worthy of peer-reviewed publication, but to do so using subject matter that is new or outside their primary discipline. The expertise of the library professionals in the map library allowed students to interact with geospatial data and necessary software at a level that ultimately led to five student-led research projects being published in the international peer-reviewed journal *Cartographica* in June 2017 (Maclachlan and Lee 2017). The challenge of organizing thoughts and arguments for an international audience required the undergraduate researchers to take true ownership of their ideas; their success would not have been possible without the in-house expertise of the map library professionals.

Fig. 3. *McMaster Arts and Science Program undergraduate students examining historical maps with Gord Beck, map specialist. Photograph courtesy of McMaster University Communications and Public Affairs*

The Role of the Library in "Traditional-Discipline" GIS Courses

Given the range of spatial analysis expertise that exists between disciplines and instructors, it is reasonable to assume that support requirements vary among courses. Departments with strong GIS programs will likely have less need for technical expertise for their courses but will often require specific data for teaching and research purposes. While not all courses require the same amount or type of support from the map library, there remain opportunities to add value, nonetheless.

Narrative #4—The Role of the Map Library With Instruction in "Traditional Disciplines"

Pat DeLuca, Instructor, School of Geography and Earth Sciences
McMaster University

Teaching courses that are entirely GIS related, I incorporate GIS and all sorts of spatial data regularly. In the introduction to GIS, we (the teaching team for the course, including the instructor and the teaching assistants) set out to teach the students the basics of using a well-known GIS software, ArcGIS. Accordingly, different themes for each of the assignments are selected to make use of a variety of spatial data. The third-year courses, Advanced Vector GIS, Advanced Raster GIS, and Remote Sensing, also use ArcGIS and an array of other spatial products. The fourth-year course, Special Topics in GIS, uses a variety of tools in the ArcGIS platform. Finally, Spatial Statistics uses R, ArcGIS and GeoDa. We were an Esri Development Center and now we are an Esri Canada Centre for Excellence for GIS, so using Esri software products makes the most sense for us. Esri also has the largest market share and many companies use a variety of its products. My role in each of these courses is either as an instructional assistant (Intro and Vector) or as an instructor.

With respect to challenges with integrating data and technology into instruction, I find there are none on the technical side as I am—safe to say—an expert in this area with 20-plus years of experience. On the data side, there are always challenges in finding quality data to use for instruction and in supervision of thesis students. In particular, any remote sensing data aside from Landsat and very few others is quite expensive. When teaching Remote Sensing, I am stuck with Landsat products, which is fine for most parts, but for some instances using finer resolution, even for demonstration only, would be beneficial.

The benefits of using spatial data/GIS are many, but primarily, it helps develop spatial thinking. This critical skill set will benefit students a great deal in the job market now and in the future. Many can improve their communication and dissemination of information through mapping. Take something like Code Red, for instance (DeLuca, Buist, and Johnston 2012), where instead of reams of tables and statistics, we have 25 maps that communicate the health of the City of Hamilton in a much more effective way.

I have always used the library to help with course projects in Advanced Raster GIS. Typically, Jay Brodeur (or John Maclachlan or Cathy Moulder before) would come into the class to let the students know about the variety of data available to them and how to access it. Then, the students would go on their way forming topics and collecting data for analysis, getting help from the library when necessary. In my view, the library staff were very effective in this role, and not much could be improved.

I believe the library can play an important role in instruction, particularly outside the suite of GIS courses. I fully believe that everyone can benefit from GIS on campus, but of course we could never teach them all here in the McMaster School of Geography and Earth Sciences. It is not necessary for all students to have the level of depth we offer, nor do most on campus want it, but the library instructors can help in other disciplines, perhaps by thinking about an exercise or two using GIS to illustrate concepts instructors are teaching in their classes. They can offer workshops to those interested in learning some basics of GIS. They can also point people to me. I have access to unlimited Esri Virtual Campus courses, and I can grant them access to these to introduce them to concepts in GIS using the ArcGIS platform.

Introducing Spatial Literacy Concepts to First-Year Students

Teaching complex topics such as spatial literacy and technology to large (and growing) first-year classes who have minimal—or in some cases, no—background with such material is a difficult undertaking that requires varying approaches to help the student experience (Maclachlan et al. 2014). It was for this reason that the spatial literacy modules were initially created. An effective teaching strategy is to allow students to interact with the material (Payne 2006) and, where possible, to have interactions with the course material occur within smaller groups (Jenkins et al. 1993). With approximately 30 to 35 separate tutorial sections, with up to 40 students in each, it became untenable for the library professionals in the Map Collection to teach the basics of spatial literacy and still allow students time to interact with the course material and resources. The online literacy modules (figure 2) help meet this demand and allow students to interact with material at their own pace prior to beginning their work in the Map Collection (Maclachlan et al. 2014).

The following narrative comes from the perspective of Julia Evanovich, who is currently an educational developer in the McMaster MacPherson Institute for Leadership, Innovation and Excellence in Teaching, but was previously the instructional assistant for first-year geography courses at the time the online modules were implemented.

Narrative #5—Integrating Spatial Skill Development in First-Year Studies

Julia Evanovitch, former Instructional Assistant, first-year Geography program

During my role as the instructional assistant (IA) for our program's two first-year human geography courses, it was very important to incorporate GIS and geospatial data into the development of course activities and assessments. It was also important to have multiple voices and perspectives involved during the development of the teaching and learning activities. Both of the first-year courses that I have been involved with incorporate in-class introductory geospatial data activities that align with the course concepts and methods used throughout the term. These include activities that are set up at the university's Map Collection (within the campus main library) to ensure students also have an opportunity to become familiar with this space, as there are times throughout the term when students will access geospatial data resources from here; it is a critical resource for students moving forward in their studies. The resources used include fire insurance maps, atlas plates, topographic maps that use various map referencing systems, case studies regarding projections, and various other resources offered at the Map Collection. One of the assignments incorporates a blended learning approach, where prior to the in-class assessment, students are asked to complete online geographic skills modules that align with the in-class tasks. This was a new approach, as historically our Map Collection staff would provide a presentation to each tutorial group of students. Staff and students have responded positively to the blended format. Students appreciate the preparatory component prior to introduction of the assignment, and it has also been less labor-intensive for the Map Collection's staff. My role as IA was to prepare the teaching assistants who would be leading the tutorials and to regularly consult with the library staff and instructors regarding the operational planning of the tutorials. As a sessional instructor, I hold a similar role by ensuring that the teaching team and tutorials are well prepared.

One of the challenges associated with integrating geospatial data into the assessment and instructional activities is ensuring that there is enough support in the tutorials when introducing the various resources. Our tutorials hold up to 40 students, so a piece of this operational development is to ensure that accessibility standards have also been considered. The successes of these tutorials include positive feedback from students at the end of the term (and years later), the positive collaboration with the library team, and the introduction of the blended approach to introducing geospatial data. This approach has been effective, as we have used this model for the last seven years, adapting each year with the support of the teaching team and library staff. Having the library staff integrated within the first-year courses has been critical. The library staff has helped in the development and delivery of various instructional tasks such as guest lecturing, helping to develop the geographic skills online modules, co-leading training of the teaching assistants, organizing content at the Map Collection, and regularly consulting with the teaching team. Executing such assignments and

instructional activities would not be possible without the collaborative relationship that our teaching team has with the library staff. Continued development of these collaborations would allow for further discourse surrounding the value of integrating geospatial data into our instructional and tutorial activities.

What About the Students?

Both graduate and undergraduate students interact with staff at the Map Collection regularly for their coursework and individual research projects. In many ways, use of the Map Collection is not much different for these two groups, in that it revolves around teaching and research. The important difference is that, often, students work on projects that incorporate spatial data and technologies without being (or having time to become) experts in this discipline. In such cases, the embedded expertise of the Map Collection staff becomes valuable not only for their ability to help students, but also for their availability to consult with instructors to design assignments that incorporate spatial literacy instruction at an appropriate level, without overwhelming the capacity of the library staff.

The following narrative comes from PhD candidate Rebecca Lee. In her research, Rebecca examines landsystems in Iceland (Lee 2016); when possible, she also works on projects that fall under the umbrella of the scholarship of teaching and learning (Maclachlan and Lee 2017). Rebecca also acts as the lead teaching assistant for many courses that incorporate spatial technologies into their assignments.

Narrative #6—The Graduate Student Perspective

Rebecca Lee, PhD Candidate, School of Geography and Earth Sciences

As a graduate student, I have had the opportunity to use GIS within the courses I have taken and as a tool for teaching others as a teaching assistant. I have used geospatial data and GIS within many research projects, and it was a major component of my master's thesis (which was related to the analysis of digital elevation models and aerial imagery from Iceland). As a teaching assistant, I have been involved in courses that incorporate GIS in different ways. The most significant of these was the use of geospatial data in an upper-year glacial sedimentology course. One of the first labs involves the use of aerial imagery and digital elevation models to map landforms. I have found that the most significant challenge in using GIS and geospatial data in courses is the varied background of students; many have never used these programs and data before. When I conducted a seminar for a graduate glacial sediment course with a small class size, the general knowledge of the students was advanced so this was not a large issue. However, it was difficult to instruct a class of 30 undergraduate students having varied skills and backgrounds with the GIS program and data types. A significant amount of the lab time was spent teaching the basics of how to use the program, how to understand what students

were seeing on the screen, and how to manipulate the data to complete the analysis needed.

Increasingly, GIS and geospatial data are being incorporated into research projects, and providing students with the opportunity to work with these types of data is very valuable. The ability to understand and manipulate spatial data may help with future jobs or research in many disciplines. I have found it to be an incredibly valuable tool within my own research and courses, and I believe that having some basic skills would benefit students in most disciplines.

When I was an undergraduate student, the library was very helpful for finding data and providing useful resources for my projects. I now know where to find any data that I need without assistance from the library, which really shows how successful they were in teaching me how to find material on my own. The library is a great resource for finding datasets that can be used in classes by instructors and by students for research projects. I think that having people in the library who understand geospatial data and GIS programs in general is critical, as GIS is a continually evolving and growing component in many jobs that students might pursue. Though the library should be a resource for datasets and have the expertise to help students learn how to choose and find data, I think it comes down to the instructors to find methods of integrating geospatial data into instruction. As geospatial data and technologies become more common components of different jobs, it might be necessary to improve awareness of the ways to incorporate it into more classes, as well as to highlight the expertise in the library so that this valuable resource can be used and integrated within more classes.

Supriya Singh is an undergraduate student in the McMaster Integrated Science (iSci) Program and is scheduled to graduate in the spring of 2017. Because of the nature of the iSci Program (see https://www.science.mcmaster.ca/isci/), Supriya takes courses from many different programs and is the ideal person to assess the importance of spatial data from a student perspective.

Narrative #7—The Undergraduate Student Perspective

Supriya Singh, BSc Candidate, School of Interdisciplinary Sciences

As an undergraduate student completing an interdisciplinary science bachelor's degree with a focus on earth and environmental sciences, I have found that GIS and geospatial data have played a vital role in my education. The general concept of GIS was introduced to me through a guest lecture in my first-year earth science course. The guest speaker (Pat DeLuca) explained a case study where socioeconomic data were collected throughout a city and mapped to analyze trends. From this case study, I had a vague idea of what GIS could do, such as giving spatial context to a set of data. However, the value of knowing how to use GIS software to interpret geospatial data became more apparent as I continued to take higher-level GIS courses. These courses consisted of numerous assignments that required me to apply the theory of how

GIS works through navigating GIS software. For instance, my spatial statistics course taught me how to use GIS software in addition to basic statistics software in order to analyze trends in spatial data.

I have used my GIS skills and encountered geospatial data beyond GIS-focused courses. For instance, I used GIS as a tool in my honors thesis project to delineate drainage basin areas (watersheds) for discharge data I was collecting all summer. My water chemistry data were displayed using symbology across a map of my study area using GIS as well. We all know that figures better depict a story than words, and I am telling my thesis story throughout my maps. A few of my other courses, such as Wine Science, Glacial Sedimentology, and Environmental Assessment, have all incorporated a geospatial data component, stressing the importance and potential of GIS. For instance, a major assignment in my environmental assessment course is to use fire insurance plans to track the history of land use changes in a specific area in order to determine if the area is a viable option for future urban development. The integration of geospatial data was probably not necessary to deliver content, but it provided students, myself included, with an opportunity not only to mimic and experience what an environmental consultant does in an assessment, but also to learn about maps and their importance.

I have also had the opportunity to get involved with geospatial data at the Lloyd Reeds Map Collection as a map digitizer. I scanned topographic maps removed from copyright using powerful scanners with really high resolution and published these maps and their metadata online. The maps we scanned and published are accessed by students at and beyond McMaster. Individuals from engineering companies and consulting companies, business students, history students, law students, and science students all access these maps for various purposes. Throughout this job, I realized how GIS and geospatial data are so interdisciplinary in nature and can have limitless applications. As a student who has benefited from knowing how to operate GIS software and had experience working with maps, I believe that the knowledge I have gained would be valuable for all students to have through simple introduction to GIS and geospatial concepts.

Reflection and Discussion

The assembled narratives of the Map Collection users illustrates the range of applications and value of the Map Collection.

A number of common themes arise from these narratives; the first, and arguably most important, is *the need for expertise within the Map Collection*. While the centralized collection of varied and often rare cartographic materials provides scholarly value, it is apparent that instructors, researchers, and students also require guidance and instruction with spatial information in their activities. As such, there is a resounding need for map library staff to possess disciplinary knowledge and technical skills to support a wide variety of spatial information needs. As the collection development priorities of map libraries evolve from physical to digital material, the role of

the library professional will also need to evolve to accommodate this change. Additionally, with the expansion of disciplines using the map collection and its material (Youngblood 2006), it will be imperative that libraries offer expertise and relevant support to those disciplines that are new to spatial data and technologies (Scaramozzino et al. 2014).

There is a definite need for map libraries to commit to outreach within universities to meet and assess campus needs for evolving spatial technologies. While an anecdotal example, the narrative of Supriya Singh discussed guest lectures in her program as piquing her interest in spatial information. As data become available and technologies change, it is critical for the Map Collection to act as the hub of information for students, staff, and faculty by making them aware of resources and facilitating their access to them.

As their user bases increase, it will become increasingly important for map libraries to be at the forefront of teaching and learning innovation in relation to spatial literacy. The importance of spatial literacy has been well established, and the increased uptake of data and technologies has been well documented. What is unlikely to change in the near future are budgets representing the true costs of bringing this technology to as many students as possible. The use of online modules was deemed successful at McMaster University by the course instructional assistant, Julia Evanovitch, and also as evidenced by the traditional qualitative research of the student body (Vine et al. 2016). Discovering new approaches to technologies in conjunction with innovative pedagogical ideas, such as the rare map crowdsourcing project undertaken in John Maclachlan's Arts and Science class, will be necessary to increase data use in the classroom and enhance the student learning experience.

With the increased use of spatial data and technologies across university campuses, it is even more critical for the supporting resources and expertise to be housed in academically neutral areas, such as the library. As such, it is also important for map libraries to continue to provide the expertise and staff necessary to reach and support a broadening clientele of staff, students, and faculty. In addressing these requirements, map libraries have an opportunity to become teaching and learning hubs for users of varying disciplines and levels of expertise, as well as to be catalysts for research and pedagogical innovation across university campuses in the future.

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