

Data information literacy instruction in business and public health: Comparative case studies

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Abstract

Employers need a workforce capable of using data to create actionable information. This requires students to develop data information literacy competencies that enable them to navigate and create meaning in an increasingly complex information world. This article examines why data information literacy should be integrated into program curricula, specifically in the instances of business and public health, and offers strategies for how it can be accomplished. We approach this as a comparative case study within undergraduate business and masters of public health programs at Indiana University – Purdue University Indianapolis. These case studies reveal several implications for practice that apply across social and health sciences programs.

Keywords

data information literacy, instruction, academic libraries, information literacy, business, public health, data reuse

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None

Statement of Professional Qualifications of Authors

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Introduction

Graduates entering the workforce must be able to navigate personal and professional environments in which data plays an ever increasing role. The volume of available data continues to increase at an exponential rate as the internet of things grows, social media and mobile devices generate vast quantities of data, and the open data movement spreads. Graduates will need to function as critical and ethical data consumers of quantitative and qualitative data originating from organizations and systems over which they have little control. In addition, public health professionals must be capable of generating and managing data about specific communities. Both fields require fluency in identifying the data, contextual, and technical components of their information needs in order to solve problems. We describe these skills as data information literacy (DIL), a critical set of competencies for graduates entering the workforce. To best prepare our students for using data to make decisions, we believe DIL needs to be integrated throughout the curriculum. This article examines initiatives at Indiana University – Purdue University Indianapolis (IUPUI) to integrate DIL instruction into an undergraduate business program and a graduate public health program. In each case study, we describe the disciplinary and professional context for DIL instruction, examine relevant educational standards and professional competencies, describe early instructional activities, and present implications for practice.

Background

In January 2016, the Association of College & Research Libraries (ACRL) adopted a new *Framework for Information Literacy for Higher Education*, an update from the *Information Literacy Competency Standards for Higher Education* published fifteen years prior (Association of College & Research Libraries, 2015). While data had been referenced, much of the original

standards focused on information literacy skills as they relate to textual sources (Association of College & Research Libraries, 2000). The new framework is more inclusive of broader information types and practices including finding, using, and understanding data, creating flexibility to adapt as resources, technology, and pedagogy evolves. However, because the framework is less structured, it does not dive deeply into the specific data competencies students need to develop.

Since student learning outcomes drive instructional design, it is necessary to clearly describe the skills we want students to develop. We reviewed existing frameworks for data literacy and found several distinct approaches (Calzada Prado & Marzal, 2013; Carlson et al, 2011; Koltay, 2015; Mandinach & Gummer, 2012; Schield, 2004; Qin & D’Ignazio, 2010). Some consider data information literacy as a facet of information literacy, while others see it as a separate set of skills. Yet another perspective places DIL under the broad umbrella of digital literacies sharing common elements with numeric and statistical literacy. In practice, there is overlap between many of these skill sets, but DIL offers a useful way of describing these skills to students and instructors.

After reviewing the literature, we selected the framework described by Calzada Prado and Marzal (2013) because it is designed to be a common reference framework for the critical use of data as well as research data management. Thus, it is easily applied to multiple data roles - producer, manager, and consumer. Furthermore, the framework uses language that is general enough to be applied to a variety of disciplines and professions. Calzada Prado and Marzal (2013) define DIL as “the component of information literacy that enables individuals to access, interpret, critically assess, manage, handle, and ethically use data.” Their framework for data

information literacy is based on a careful review of the literature conducted across science and social science disciplines. The five-module framework covers:

1. Understanding what data is and how it affects society
2. Finding and/or obtaining data resources
3. Reading, interpreting, and evaluating data
4. Managing data including creation of metadata and collection practices
5. Using data including data handling, data visualization, and ethical use

There are differences in the practical implementation of DIL as compared to information literacy (Hunt and Birks, 2004). Each case study will describe the professional context that shapes application of the DIL competencies as well as the approach for integrating instruction into the curricula.

Methods

The cases were selected in order to compare data information literacy integration for two fields in which graduates often work as practitioners rather than academic researchers. They also provide the opportunity to examine differences between DIL instruction for undergraduate and graduate students. While the opportunity to integrate instruction into these programs arose independently, the authors identified a common approach. Educational standards were reviewed to determine how DIL can support program curricula. Reviews of professional standards and literature on employer surveys were also conducted. Particularly for the business case, these sources describe the skills that employers desire and whether recent graduates are meeting those needs. Overall, these standards and surveys helped us identify skills gaps that could be mitigated by DIL instruction. Existing library initiatives to integrate information literacy into program

curricula presented an opportunity to build on prior conversations and relationships while extending instructional support to include DIL. In both cases, curriculum mapping was the common critical step.

Curriculum mapping is a process of collaboration and communication that librarians use to determine where and when information literacy instruction should be placed within a particular course of study at the point-of-need (Bullard and Holden, 2006). This systematic process allows librarians to gain knowledge of the needs and language relevant to a particular course of study. Such knowledge facilitates better communication and creates opportunities for librarians to collaborate with instructors in identifying where information literacy fits within the planned course of study. Curriculum mapping allows librarians to position DIL within the context of specific disciplines, creating alignment between education standards and program learning outcomes. In developing curriculum maps for these cases, we incorporated professional standards and employer needs as well as academic learning outcomes.

Program learning outcomes, course syllabi, and assignments were examined to identify specific opportunities for integrating DIL skills. Program learning outcomes provide a high level framework that describes the observable skills students are expected to exhibit upon graduation. Program documents may also include student learning objectives, which are often more detailed and describe what the program intends students to learn. These outcomes and objectives are used to create course goals. Understanding this relationship between program learning outcomes, student learning objectives, and course goals enables librarians to identify and communicate how DIL instruction will support a course and the program. This knowledge enables more efficient analysis of syllabi. Examining course assignments assists librarians in identifying opportunities to integrate and assess DIL.

Case study: Undergraduate business education

Businesses wish to take advantage of the exponential growth of data, which requires the skills of data scientists and functional practitioners in all business areas. Employers are asking workers across their organizations to review, understand, and make decisions using data gathered from internal and external sources and systems. Companies desire that their employees have the ability to find and use data to determine trends, develop meaningful insights, and provide actionable recommendations to improve the business. In 2012, discussions at the Business Intelligence Congress 3 (BIC3) brought forth the recommendation that academic institutions should consider tailoring business intelligence education to generalists and specialists. BIC3 recommended that all business majors in undergraduate and masters-level graduate programs be considered generalists who need to develop data information literacy (DIL) skills that will allow them to analyze and synthesize data within their functional area (Wixom et al, 2014).

As business schools move to integrate DIL into the curriculum to meet employer needs, libraries have a prime opportunity to collaborate with faculty and curriculum committees to shape the curriculum. This case explores the skill sets and competencies desired by employers that can be developed through DIL instruction, as well as how business education standards encourage the integration of DIL into the curriculum. Understanding this context facilitates the conversation about DIL integration.

Help wanted: People who understand data

Data information literacy is relevant to undergraduates who are seeking a bachelor's as a terminal degree, particularly in the area of business (Shorish, 2015). Future business workers will need to be well versed in digital technology, social media, and big data in order to analyze

information gathered from information technology systems critically (Bisoux, 2016). Business leaders also desire to spur innovation by taking advantage of the increased access to data available through open data initiatives (Calzada Prado and Marzal, 2013). Gartner, a technology market research firm, has found that the emphasis is moving from technology of big data to application, or in other words, how can data analysis address business problems facing an organization or industry (Burton and Willis, 2015). To maximize the business value of analytics, companies need employees who understand the business and can cross the communication divide that often exists between information technology and other departments (Ransbotham et al, 2015). This requires practitioners such as accountants, brand managers, financial analysts, and buyers to be able to use, analyze, and communicate using data when managing their business.

In 2014, the Association of American Colleges & Universities (AACU) commissioned a survey of employers and college students to determine the learning outcomes that employers most valued in college graduates. The survey indicated that there are a number of learning outcomes that employers rank as very important but feel that recent graduates are not well prepared to address (Hart Research Associates, 2015). See **Table 1**.

Table 1. Summary survey results from AACU employer survey (Hart Research Associates, 2015)

| Learning outcome | % Employers view as very important | % Employers who feel graduates are well prepared |
|---|---|---|
| The ability to effectively communicate in writing | 82% | 27% |
| Ethical judgement and decision making | 81% | 30% |
| Critical thinking and analytical reasoning skills | 81% | 26% |
| The ability to analyze and solve complex problems | 70% | 24% |
| The ability to locate, organize, and evaluate information from multiple sources | 68% | 29% |
| The ability to work with numbers and understand statistics | 56% | 28% |

DIL integration into business curriculum will meet some of employers' top needs and helps address the skills gaps employers are observing in new college hires.

Critical thinking and data information literacy

The desire for new hires to have critical thinking and/or analytical skills is emphasized in the AACU survey and business information literacy literature (Hart Research Associates, 2015; Klusek and Bornstein, 2006; Sokoloff, 2012). Critical thinking involves the process of analyzing, evaluating, and interpreting information (Schild, 2004). In business, it also includes the ability to apply that information to make business recommendations.

Three elements contribute to the development of critical thinking skills in undergraduate business students: context, business skills/knowledge, and literacies. Undergraduate education influences all three elements. Context is constructive and created through an individual's life experience and culture. According to Calzada Prado and Marzal (2013), critical thinking draws from a person's knowledge and values in addition to their mathematical and statistical aptitudes. Liberal arts education expands the context of reference for individuals across disciplines, while business school curriculum provides discipline knowledge and skills. The third element needed for developing critical thinking skills, literacies, is developed throughout the entire curriculum, which includes information literacy, numeracy, statistical literacy, and data information literacy (Schild, 2004; Stephenson and Caravello, 2007).

Picking a data information literacy framework

Cunningham (2003) lists a number of information competencies for business students that were aligned with the information literacy standards published by ACRL in 2000. These competencies delve deeper into business education needs in regards to information literacy, statistical literacy, and data information literacy and are still relevant today. However, they were drafted prior to the explosion of big data and the increased desire employers for data-driven decision making.

Additional emphasis should be placed on teaching data information literacy (DIL) within

academic business programs. Calzada Prado and Marzal's (2013) framework provides guidance on the competencies students need to develop in regards to data, better preparing them for the working world. See **Table 2** to understand how DIL competencies from Calzada Prado and Marzal's framework align with learning outcomes that employers value.

Table 2. Alignment of employer survey learning outcomes to data information literacy competencies

| AACU Learning Outcome (Hart Research Associates, 2015) | Data Information Literacy Competency (Calzada Prado and Marzal, 2013) |
|---|---|
| The ability to effectively communicate in writing | 5.2 Producing elements for data synthesis |
| Ethical judgement and decision making | 1.2 Data in society: a tool for knowledge and innovation. 5.3 Ethical use of data |
| Critical thinking and analytical reasoning skills | 1.1 What is data 3.1 Reading and interpreting data 3.2 Evaluating data |
| The ability to analyze and solve complex problems | 1.1 What is data 5.1 Data handling |
| The ability to locate, organize, and evaluate information from multiple sources | 1.1 What is data 2.1 Data sources 2.2 Obtaining data 4.1 Data and metadata collection and management |
| The ability to work with numbers and understand statistics | 3.1 Reading and interpreting data |

Meeting business education standards

The business education curriculum standards published by the Association to Advance Collegiate Schools of Business (AACSB), a global accrediting body for undergraduate and graduate business education, and the National Business Educators Association (NBEA), a professional organization supporting business educators in the United States of America, support the competencies listed in Calzada Prado and Marzal's framework.

The AACSB addresses curriculum content in Standard 9 of their *Eligibility Procedures and Accreditation Standards for Business Accreditation*. The standards state the expectation that students graduating with a Bachelor's Degree or higher develop the following skills (Association to Advance Collegiate, 2013):

- “Written and oral communication (able to communicate effectively orally and in writing)
- Ethical understanding and reasoning (able to identify ethical issues and address the issues in a socially responsible manner)
- Analytical thinking (able to analyze and frame problems)”

Standard 9 also states that curriculum should cover several general business and management knowledge areas including (Association to Advance Collegiate, 2013):

- “Information technology and statistics/quantitative methods impacts on business practices to include data creation, data sharing, data analytics, data mining, data reporting, and storage between and across organizations including related ethical issues
- Economic, political, regulatory, legal, technological, and social contexts of organizations in a global society
- Social responsibility, including sustainability, and ethical behavior and approaches to management”

The skills and knowledge areas in the AACSB standards are interdependent and should be considered holistically when developing curriculum. The emphasis on data in the AACSB standards in conjunction with employer demand for skilled workers makes it clear that integrating DIL into the curriculum is important.

Mapping to the curriculum & starting the conversation

The complexity of different functional courses of study (e.g. accounting, finance, marketing, etc.) creates a challenge when attempting to determine where to integrate DIL instruction within

the business curriculum. The NBEA's (2013) standards provide guidance as to where DIL instruction could naturally fit in to college-level business curriculum (level 4) by functional area, and can be used to identify opportunities for collaboration with faculty. See **Table 3**.

Table 3: Data information literacy competency mapped to national standards for business education by subject/functional area (National Business Educators Association, 2013). See detailed curriculum map at <http://hdl.handle.net/1805/10823>.

| Data Information Literacy Competency (Calzada Prado and Marzal, 2013) | Subject/Functional Area as specified by NBEA National Standards | | | | |
|--|---|----------------|------------------------|------------|-----------|
| | Accounting | Communications | Information Technology | Management | Marketing |
| 1. Understanding data | | | | | |
| 1.1 What is data | | | | | |
| 1.2 Data in society: a tool for knowledge and innovation. | | | × | | × |
| 2. Finding and/or obtaining data | | | | | |
| 2.1 Data sources | | | × | | × |
| 2.2 Obtaining data | | | × | | × |
| 3. Reading, interpreting and evaluating data | | | | | |
| 3.1 Reading and interpreting data | × | × | | × | × |
| 3.2 Evaluating data | × | × | | × | × |
| 4. Managing data | | | | | |
| 4.1 Data and metadata collection and management | × | | | × | × |
| 5. Using data | | | | | |
| 5.1 Data handling | × | × | × | | × |
| 5.2 Producing elements for data synthesis | × | × | × | | × |
| 5.3 Ethical use of data | × | × | × | | × |

Successful DIL integration within the business curriculum requires the assimilation of concepts into course content, assignments, and assessment. The business liaison can support this by starting the conversation and collaborating with faculty and curriculum committees. At IUPUI, I prepared to do this by first refreshing the student learning objectives (SLOs) used in library instruction planning for the undergraduate business program. Twenty-six SLOs were drafted supporting the development of information literacy skills, business information literacy skills,

and data information literacy skills, informed by Cunningham's (2003) article, the ACRL *Framework for Information Literacy for Higher Education* (2015) and the Calzada Prado and Marzal (2013) data information literacy framework. These SLOs were mapped to specific courses within the undergraduate curriculum to create a guide for incorporating library instruction. The curriculum mapping process identified opportunities where inserting DIL aligns with current course objectives.

When speaking to business faculty at IUPUI, some associated DIL with the skills needed for conducting academic research, less applicable for undergraduate business students. From my experience, discussing data as it relates to critical thinking, as well as using disciplinary terms such as business analytics and business intelligence particularly resonated with faculty. One successful tactic was the use of strategic communications that introduced and reminded faculty of data sources available for research and teaching. At IUPUI, I have sent short e-mails regarding updates to research guides or to introduce specific data sources, as well as have spoken briefly at faculty meetings. These communications created demand for instruction sessions and spurred faculty to promote data sources to students within the classroom.

Integration into I-CORE

After reviewing the undergraduate business curriculum, I found that a natural place to start integrating data information literacy (DIL) instruction was through I-CORE, the integrated core curriculum at the Kelley School of Business. When admitted into business school after their sophomore year, students are required to take four upper-level classes their first term: finance, marketing, operations and supply chain management, and team dynamics and leadership. These courses culminate with the I-CORE project when student teams analyze the financial feasibility

for either offering a new product/service or entering a new market for a local client. This project provides several opportunities to integrate DIL through library instruction and research consultations.

Building relationships and starting the conversation with I-CORE faculty was the first step. Prior to spring 2016, the library provided support for I-CORE through a 30-minute resource briefing followed by optional research consultations with individual students and teams. During the fall of 2015, I assessed the I-CORE instruction program to understand if library instruction and research consultations were influencing student performance. I conducted a bibliographic review of student deliverables to determine whether students used business databases and/or online resources. Student performance was also assessed in the context of whether students participated in research consultations. Students who had research consultations showed stronger performance and were more likely to use business databases. I also found that the databases covered and questions asked were similar during these consultations. The faculty were receptive when I shared these findings and invited me to collaborate when updating the spring 2016 project curriculum. Project planning sessions allowed me to introduce DIL. During these discussions, I made the case for a longer instruction workshop that would allow me expand on the information literacy and DIL skills taught during research consultations to a larger base of students.

The I-CORE research workshop helped students develop skills in four of the five competencies in the Calzada Prado and Marzal framework: understanding data; finding and/or obtaining data; reading, interpreting & evaluating data; and using data. The two-hour interactive instruction session was designed to introduce students to business resources while teaching research strategies and evaluation skills. During the workshop, I introduced data through a discussion about the term “big data”, following up with questions about how data could affect their project,

future work, personal lives, and society (Calzada Prado and Marzal's first competency – understanding data). I reinforced this discussion as I introduced market research databases and while students explored resources.

Students were introduced to multiple databases and sources during the workshop enabling the development of the second competency – finding and/or obtaining data. Using the US Businesses database, a directory available in ReferenceUSA, students learned how to obtain information about competitors within a geographic location, locating detailed information including a sales revenue value, which in the case of private companies is estimated using a proprietary algorithm. I discussed with students the importance of searching for data definitions within databases, as well as the advantages and disadvantages of using data that is calculated through algorithms, developing the third competency – reading, interpreting, and data evaluation skills.

The US Consumers/Lifestyles database within ReferenceUSA illustrated to students how consumer data can be accessed to generate customer-prospecting lists and analyzed to determine market trends. In this database users can segment geographic markets by lifestyle and demographic criteria. The consumer lists provide data at the individual level, including demographics data, lifestyle interests, and contact information. This example brought home the earlier discussion about the impact data has on society and the ethical issues that exist, helping students better understand data (Calzada Prado and Marzal's first competency) and use data (the fifth competency). Students were introduced to the concepts of data producers and data consumers through discussion. They realized that customers/consumers are data producers with each piece of information they choose to share using social media, including when they take fun personality quizzes, such as "What shoe would you be?" This conversation segued into the

responsibility of data consumers, such as businesses, who need to consider ethical issues including privacy when accessing, using, and storing data.

Following the required workshop, students could schedule optional research consultations. The research consultations provided additional opportunity to teach DIL as students searched for marketing, operational, and financial data. During research consultations, I helped students develop the ability to find data by teaching them how break down research questions into key concepts before assisting them in developing search strategies to locate information and data. Students learned to navigate subscription and free resources, such as Demographics Now and American Fact Finder. Through guided discussion students learned how to use data, developing data analysis strategies to create sales forecasts and financial analysis. These discussions included the importance of documenting data collection and assumptions made during data synthesis. Students gained understanding on how this documentation, including citing sources, created credibility for their work while providing their audience the ability to find and use data integrated into their projects.

Next steps

The next area to develop of I-CORE instruction centers on data visualization with the goal of providing guidance to students in regards to tailoring messages to communicate data clearly and ethically. This aspect of using data comes into play towards the end of the project as students are preparing their final presentation and report deliverables. One potential option is the introduction of a self-paced tutorial or instructional video that discusses data visualization best practices. However, it may be more appropriate to map this instruction to an earlier course in the student's curriculum such as business communication.

Efficacy of this library instruction is being assessed in a number of ways. At the end of the research workshop students were asked to complete a short 3-2-1 formative assessment where students reflected on three things they learned, two things they found interesting, and one thing that they still had a question about. This feedback helped me understand the most engaging points of the session as well as areas of confusion. Feedback received clearly showed that students found the discussion around data, particularly the ethical use of data as well as the volume and content of data available for analysis illuminating. Of the responses, 14% of the students in spring 2016 and 23% in the summer 2016 commented on data information literacy topics as things they found interesting during the workshops.

In addition to workshop feedback, I have reviewed a selection of deliverables to evaluate the variety of data sources, quality of sources used, and the integration of data within the deliverables. Short-term assessments indicate that students appear to be making progress in developing DIL competencies as they work through deliverables during I-CORE. However, additional instruction is needed, particularly in regards to producing elements for data synthesis (Calzada Prado and Marzal's fifth competency). I am collecting longitudinal data on deliverables to draw definitive conclusions in regards to program effectiveness. Measuring DIL through assessment will be a moving target as it is further integrated into the curriculum.

Case study: Graduate public health education

Opportunities in public health

Public health services affect our daily lives by preventing us from harm in numerous ways – by monitoring the water we drink, the food we eat, the air we breathe, personal care products, and the safety features in our cars, schools, and workplaces. The sheer scope of public health services

combined with the diversity of backgrounds, technological systems, and stakeholders poses unique challenges for the public health profession. It is a highly multidisciplinary field, drawing on evidence, theories, and methods from sociology, communication, medicine, environmental science, informatics, and statistics, among other fields. Data and information used to provide public health services are similarly diverse and are generated at many levels – local, state, regional, national, and international. Public health services rely on complex technological and organizational systems to gather and distribute an amalgamation of structured and unstructured data. In doing so, these systems are shaped by other systems (e.g., education, health care, transportation, etc.) as well as social, political, fiscal, and environmental issues. Finally, public health professionals face incredible diversity with regards to the professionals and communities they serve. This demands fluency in accessing, evaluating, and communicating information. Public health issues increasingly cross boundaries of education, wealth, and location. As these concerns become globalized, so too must our systems for prevention, monitoring, and response. Bolstering the data information literacy of the workforce has great potential to increase the quality of life for many communities by improving public health service. To that end, this case study will focus on the primary professional degree, the master of public health (MPH), to identify opportunities to develop a new generation of data literate practitioners.

Public health practice

The central premise of public health practice is that people are interdependent. This is expressed in the values and beliefs underlying the Code of Ethical Practice (Public Health Leadership Society, 2002). Solving the public health issues arising from the complex interdependencies between people and their environment requires a workforce that can collaborate to build and

continuously improve public health systems. *The 10 Essential Public Health Services* (Centers for Disease Control, 2014) include the following activities:

- monitor health status to identify and solve community health problems
- diagnose and investigate health problems and health hazards to the community
- inform, educate, and empower people about health issues
- develop policies and plans that support individual and community health efforts, and
- evaluate the effectiveness, accessibility, and quality of personal and population-based health services

In a 1988 landmark report, the Institute of Medicine (IOM) noted that decision making in public health is too often driven by “crises, hot issues, and concerns of organized interest groups” (Institute of Medicine, 1988:4). Jacobs et al (2012) also noted the tendency for policy decisions to stem from political and media pressures, anecdotal evidence, and tradition. Evidence based public health (EBPH) provides guidance to counteract this tendency. As in medicine, nursing, and other health professions, evidence based practice has deeply affected public health services. Funders and national initiatives such as Healthy People 2020 encourage the use of evidence based interventions and approaches. EBPH integrates science-based interventions with community preferences for improving population health (Jacobs et al, 2012). Public health studies are rarely as clean and controlled as randomized-controlled trials; thus, interpreting results requires keen awareness of the context in which the data were collected, particularly with respect to caveats and limitations resulting from a lack of control groups. EBPH demands that professionals can use data and information systems systematically, make decisions based on the best available peer-reviewed evidence, and disseminate what is learned.

Data, specifically surveillance of infectious diseases, is the cornerstone of public health service and research. Public Health Surveillance (PHS) is a critical tool for understanding a community's health issues. It is also an ongoing set of processes for planning and system design, data collection, data analysis, interpretation of results, dissemination and communication of information, and application of information to public health practice (Hall et al, 2012). Although advances in computing and information sciences have greatly improved surveillance since its origins in the early 20th century, there is a long way to go before PHS systems are interoperable, accessible, and effective on a global scale. Less than a quarter of respondents (22%) of a 2009 CDC survey agree that CDC surveillance systems work well for today's information technology systems (Thacker et al, 2012). Technology can act as both a facilitator and a barrier. Public health professionals will need to understand how technologies and systems shape how public health data is stored, consolidated, and disseminated (Thacker et al, 2012). These conditions – the scope of public health services, an increasing emphasis on evidence based public health, and public health surveillance – all demand a highly skilled workforce that can gather, handle, and use data responsibly to solve public health problems. Librarians can support the development of such a workforce by integrating DIL instruction into public health curricula.

Meeting professional standards for public health practice

The Council of Linkages between Academia and Public Health Practice (CLAPHP) is a collaboration of 20 national organizations whose aim is to improve public health education and training, practice, and research. The Council fosters, coordinates, and monitors the connections between academia, the public health practice, and healthcare communities. Thus, they are well placed and designed to set forth a “consensus set of skills for the broad practice of public health.” The competencies, organized by eight practice domains, are valuable for assessing workforce

knowledge and skills, identifying training needs, and creating workforce development and training plans. The three practice domains selected for curriculum mapping included analytical/assessment skills, policy development/program planning skills, and public health sciences skills. Example competencies for each domain are listed below.

- Analytical/Assessment Skills 1A6: “Selects comparable data (e.g., data being age-adjusted to the same year, data variables across datasets having similar definitions)”
- Policy Development/Program Planning Skills 2A5: “Identifies current trends (e.g., health, fiscal, social, political, environmental) affecting the health of a community”
- Public Health Sciences Skills 6A4: “Retrieves evidence (e.g., research findings, case reports, community surveys) from print and electronic sources to support decision making”

The remaining five practice domains are more relevant to information literacy instruction due to their focus on textual information. Each practice domain describes competencies at three levels or tiers of skill: entry-level or frontline staff, program management or supervisory level, and senior management or executive tier. For this case study, I focus on the first tier competencies for entry-level or frontline staff.

Mapping data literacy to professional competencies

The process of mapping the Council practice domains to DIL competencies revealed substantial opportunities for instruction to address professional standards. Generally, DIL is deeply embedded in public health practice. The Council practice domains substantially cover four of the DIL competencies. Managing data is the one DIL competency that is not explicitly discussed. It

is only mentioned as it relates to ethical principles, laws and guidelines, and using information technology effectively. See **Table 4**.

Table 4: Mapping DIL competencies to selected CLAPHP core competencies (see full curriculum map at <http://hdl.handle.net/1805/10825>).

| DIL Competencies | CLAPHP Practice Domains | | |
|--------------------------------------|-------------------------------------|-------------------------------|---|
| | Analytical/Assessment Skills | Public Health Sciences Skills | Policy Development/Program Planning Skills |
| Understanding Data | 1A1, 1A2, 1A11 | 6A1, 6A2, 6A3 | none |
| Finding/Obtaining Data | 1A3, 1A4, 1A5, 1A6, 1A8, 1A11, 1A12 | 2A1, 2A2, 2A6, 2A10 | 6A4, 6A7, 6A8 |
| Reading/Interpreting/Evaluating Data | 1A3, 1A4, 1A6, 1A7, 1A11, 1A12 | 2A1, 2A2, 2A3, 2A5, 2A7 | 6A5, 6A6, 6A7 |
| Managing Data | 1A3, 1A4 | 6A7 | none |
| Using Data | 1A3, 1A4, 1A6, 1A11 | 6A3, 6A7, 6A9 | 2A1, 2A2, 2A3, 2A4, 2A5, 2A8, 2A9, 2A11, 2A12 |

Calzada Prado and Marzal (2013) describe understanding data as knowing what is meant by data, what types of data exist, and the role of data in society. There are two relevant Council competencies here. First is the ability to identify quantitative and qualitative data and information to assess the health of a community. The second is applying ethical principles and using information technology (IT) in all aspects of working with data. Understanding public health data is particularly challenging because the sources of evidence are diverse and include data collected in uncontrolled settings and experiments. Students must learn to recognize ways that technological and organizational systems producing public health data embed biases, limitations, and assumptions within the data.

Finding or obtaining data in public health requires professionals to navigate complex systems with variable ethical and legal constraints that guide how data are collected, managed, stored, and shared. The distribution of this DIL competency across the Council practice domains reflects its importance and difficulty (see curriculum map <http://hdl.handle.net/1805/10825>).

Professionals should be able to select or collect valid and reliable quantitative and qualitative data, describe assets and resources available to improve the health of a community, and

contribute to the public health evidence base. While doing so, they must also be able to interact ethically with the systems in which data are held.

Perhaps the most important thing we can pass on to students is the value of a critical approach to reading, interpreting, and evaluating data. Again, this DIL competency is pervasive across the three Council domains. Fundamentally, it comes down to knowing the origins and characteristics of the data. Where did it come from? Who produced it? How is it described? What are its limitations and biases? Guidelines for EBPH practice provide substantial guidance for teaching this DIL competency by describing the different forms of evidence, as well as processes and strategies for using data (Brownson et al, 1999). However, EBPH is only one lens for critical evaluation. As public health practice advances, professionals will need to be able to adopt other lenses.

In contrast to the other DIL competencies, only the analytical/assessment practice domain addresses data management. Even here, it is only mentioned generally and in relation to ethical, legal, and technical issues. At the professional and program levels, no specific guidance is provided regarding how data are to be managed. However, particular biostatistics and epidemiology courses in the MPH program provide strategies for data management, usually in the context of a particular statistical program (e.g., SAS or R). This gap corresponds with trends in other disciplines to exclude practical data management skills in developing competencies or training (Carlson et al, 2011; Maybee et al, 2015; Carlson and Bracke, 2015). The lack of coverage by the Council practice domains may make it more difficult to make the case for integrating these skills into program curricula. Fortunately, public health course projects often require students to make use of data, providing an opportunity to demonstrate the relevance of data management practices.

Using data includes tasks such as preparing data for analysis, producing elements for data synthesis, and using data ethically. All three Council practice domains include competencies addressing data use. Professionals must recognize how biases, and limitations, and assumptions intrinsic to the data may affect their analysis and interpretation. Within the framework of EBPH practice, Brownson et al (1999) provides excellent guidance for making use of data. The authors describe a seven-stage process for new practitioners to apply their knowledge in a practice setting. They articulate the types of public health interventions (emerging, promising, effective, and evidence-based) and offer classifications for evaluating and using them. These classifications lead to three types of actions indicated, depending on the evidence available. This framework makes EBPH approachable to students and professionals. As students are taught evidence-based approaches, incorporating DIL competencies related to understanding, finding and obtaining, and using data have the potential to simultaneously deepen students' DIL and proficiency with EBPH practice.

The curriculum map provides clear evidence for the value of integrating data information literacy instruction into public health program curricula. There is substantial overlap between the Council practice domains, principles of EBPH, and DIL competencies. While the Council practice domains and MPH program competencies discuss the evaluation and use of data holistically, they do not provide the detailed guidance needed to develop classroom instruction. Thus, mapping DIL competencies to program and professional standards reveals critical gaps in the curriculum. Next, I identified opportunities within the MPH curriculum for DIL instruction.

Integrating data information literacy into the MPH curriculum

The twelve program competencies for the Fairbanks School of Public (FSPH) Health Master's in Public Health program at IUPUI are designed to communicate to students the skills that they will develop throughout their coursework. These competencies were mapped to Calzada Prado and Marzal's (2013) DIL competencies to determine alignment with academic learning goals (see curriculum map <http://hdl.handle.net/1805/10825>). In combination with syllabi, program competencies were analyzed to identify opportunities for DIL instruction within the core curriculum, which is composed of five required courses that can be taken in any order. The flexibility in the program does not lend itself to a progressive or coordinated instructional approach. Instead, I identified DIL competencies that could be addressed in each course to create a menu of classroom data activities. For each competency, I developed guiding questions for discussion as well as active learning opportunities and course assignments.

Table 5: Opportunities for data information literacy instruction within the core MPH courses

| Data Literacy Competencies | General Discussion | General Active Learning & Assignments | Course-specific Activities |
|---|---|--|---|
| Understanding data | What types, formats, & sources of data are used in this approach to public health? (e.g., biostatistics/epidemiology/environmental science/ health policy & management/ social & behavioral sciences) | Peer training session: Students will explore core public health data topics and present to peers (small group activity). | <i>H501: U.S. Health Care System and Health Policy</i> Students will explore the technical, political, social challenges of conducting research in health policy. They will also identify open sources of data. |
| Finding/obtaining data | Who generates or gathers data for [the types of public health services covered in this class]? | Find and access public data relevant to the course project/paper, cite that data appropriately, and submit a description of your strategy and sources. | <i>E517: Fundamentals of Epidemiology</i> Students will explore core public health data sources, methods, and instruments/systems and present to peers (small group activity) for epidemiologic questions. |
| Reading/interpreting/evaluating data | How can you tell if data are accurate? Authoritative? Current? Relevant? Useful? How do you recognize biases, assumptions, and limitations in data? | Students will break into small groups to develop documentation for an existing dataset including: the biases, assumptions, and limitations of the data for a particular research question. | <i>A519: Environmental Science in Public Health</i> Students will explore and critically appraise a particular environmental health data set. They will complete an evaluative report on its use for the course project. |

| | | | |
|----------------------|--|--|--|
| Managing data | Why is it important to manage data? What are the key challenges in managing public health data? What specific skills and tools can help you to manage data? | Hands-on workshop demonstrating strategies for: -defining roles & responsibilities for a project -file organization & naming, file versioning -data security & encryption -annotation and documentation (e.g., data dictionaries, codebooks, metadata, etc.) | <i>B551: Biostatistics for Public Health</i> Students will enhance or anonymize an existing dataset through processing, annotation, documentation, recoding, de-identification, masking, etc. OR Students will create a functional data management plan for a proposed study. |
| Using data | What legal, regulatory, and ethical norms affect the use of data? What are the common practices for sharing data? Reusing data? Are licenses used? Data use agreements? How are data attributed to the creators? | Students complete the data outcomes mapping exercise. Students describe the permissions and restrictions associated with the data they are reusing. Require students to cite data in the appropriate style in their papers and project reports. | <i>S500: Social and Behavioral Science in Public Health</i> Students will synthesize data from multiple sources to create a new dataset. OR Students will conduct analysis to develop evidence-based programs, interventions, policies, etc. |

Instructors will be able to select competencies and supporting activities from an instructional menu, an abbreviated sample of which is provided in **Table 5**. One relatively simple approach is to incorporate discussions about data into existing topical sessions across the core courses. These discussions could then direct students to extra-curricular workshops or campus services for further support. A more active approach is to embed classroom activities that cover both conceptual and procedural skills to be assessed. For example, a discussion about the value of documenting data could be paired with a hands-on exercise in creating a data dictionary or annotating a processing or analytical script. These activities would fit well in the core biostatistics course (B551). Given the disciplinary variety in public health, it is crucial to develop customized examples for each course. Full integration into the curriculum requires instructors to incorporate DIL competencies into course content, assignments, and assessment.

Recent conversations with environmental health science (EHS) faculty have presented another path for DIL instruction. I approached the department chair and a former collaborator to discuss integrating DIL skills into the EHS research methods course. Unexpectedly, they responded by inviting me to redesign and teach the research methods course for their department. Both the redesign and instruction are collaborative endeavors. For example, faculty will provide guest lectures on specific research methods (e.g., interviews, observation, etc.). This was possible because the department had already identified the need for customized EHS content as well as more comprehensive coverage of research data management and scholarly communication topics. This presents an incredible opportunity to embed DIL within a core research methods course. Rather than relegating DIL to a single class session, it will be woven into the fabric of the course. For example, students will discover best practices for data management specific to each of the research methods concurrent with learning about the method. They will also examine how data practices shape and are shaped by ethical guidelines, EBPH, funding agency guidelines, and publisher requirements. When possible, instructors will identify available public health data to be used in course assignments. Transforming open and shared public health data into open educational resources will provide students with authentic learning experiences while demonstrating the value of data sharing, curation, and reuse. This fills a notable gap in the Council practice competencies. Professionals need to be aware of the common models for data sharing and exchange in public health (e.g., restricted data sets with use agreements, limited data sets, public access data, etc.) and the resulting technical and administrative procedures. Importantly, this course presents an opportunity to assess DIL instruction across multiple authentic assignments. It may also provide a model for integrating DIL into other graduate research methods courses. Currently, the pilot course is being developed for the spring semester

of 2017. Though the research methods course is a unique opportunity, I will continue to discuss with faculty the value of incorporating DIL into other courses using activities like those described in Table 5. In order for students to develop adequate skills to succeed as professionals, DIL competencies must be integrated throughout the program curriculum.

Beyond the classroom, providing DIL training for the existing workforce is crucial to the development of an international system of interoperable data and compatible networks. In addition to providing professionals with practical strategies and knowledge of good data practices, instruction should introduce data governance and stewardship issues that will affect practice and research. This training should be strongly rooted in current practice and technologies and look forward to potential solutions for public health research and practice. Academic public health centers are often providers of continuing education, which presents an opportunity for librarians to offer DIL training to the existing workforce.

Discussion

These case studies have highlighted the importance of data information literacy in two professions, while demonstrating the value of integrating DIL into program curricula. Such integration can address academic standards while developing a data literate workforce. Despite distinct differences between the practice setting, types and sources of data, and context for application, we were able to identify common approaches. The business case, which largely focuses on data consumers, reveals that there is a particular need for professionals who can translate needs between content experts and information technologists who support and design information systems. In public health, professionals who can function as data creator, manager, and consumer are needed to solve 21st century public health challenges.

The literature review indicates that employers' desire to make information actionable is driving demand for data skills in the business and public health workforce. Professional and academic standards clearly communicate the expectation that graduates have data skills (i.e. data creation, data sharing, data analytics, data mining, and data reporting). One key difference discovered is that the public health standards are primarily organized by skill domains rather than professional subject/functional area. This type of disciplinary knowledge is valuable for framing the discussions that librarians have with disciplinary faculty. In both cases, when conversing with faculty it was important to illustrate how DIL instruction prepares students to succeed as professionals while supporting program learning outcomes. The selection of DIL competencies for integration should be informed by knowledge of the data roles that professionals for that particular field will hold. For instance, business professionals are largely data consumers and occasionally data handlers. In general, they are not creating data unless they work in a specialized field such as market research. However, public health professionals often take on multiple roles with respect to data.

Analytical skills are heavily emphasized in both fields. However, the terminology, examples, and resources used vary greatly. Librarians must develop this disciplinary knowledge. Undergoing the curriculum mapping process enabled us to better understand how employer needs, professional and educational standards, and program learning outcomes intersect with regards to DIL. The knowledge gained through this process facilitated collaboration with faculty to develop course content, assignments, and assessment.

Providing concrete examples that are familiar and relevant is crucial for achieving faculty buy-in and engaging students, particularly when teaching the ethical use of data. Although there is much discussion about the ethical issues associated with business intelligence and public health

surveillance data, the educational standards and professional competencies lack practical guidance. This is a clear area of need that could be addressed by collaborating with faculty to develop authentic scenarios that will resonate with students. Similarly, a dearth of practical guidance for data management is apparent in both professions. Beyond mentioning the need for these skills, guidance specific to handling, processing, analyzing, and storing data is not offered. As a result, students feel the least prepared to tackle these tasks. Therefore, data management is another area of need for collaboration between librarian and faculty to develop instruction that integrates practical strategies. However, integrating DIL instruction into course content, assignments, and assessment is challenging in already full curricula. It requires faculty to recognize the value of these skills and make room for DIL in their courses. Despite these challenges, there are options available with low barriers to entry. In business, strategically sharing information about existing resources was an effective strategy. In public health, helping instructors identify the DIL and research data management issues associated with current public health issues is an effective conversation starter. In both cases, it has been faculty interest that enabled the projects to move forward.

Finally, effective strategies for assessing data literacy instruction are still emerging. Can student performance be tied to data information literacy instruction? How can we deliver DIL instruction effectively in face-to-face, online, and hybrid formats? Can we build common start-of and end-of-program assessments? Is it possible to gather employer feedback on the preparedness of interns and new hires? How else can we determine long-term outcomes?

Implications for practice

In comparing these case studies, we identified five common steps for integrating data information literacy instruction into disciplinary curricula. The first is to ask stakeholders—employers, practitioners, and faculty instructors—to identify the particular skills gaps they see as most important. This could be accomplished by interviewing stakeholders, reviewing employer surveys, or analyzing professional or academic competencies. Second, map the identified skills gaps to DIL competencies and analyze course syllabi to identify content, assignments, and assessment opportunities. The third step is to convey these opportunities to faculty by situating the conversation within disciplinary topics and priorities. Once the initial steps are completed, the fourth step is to design instruction. Consider repurposing or adapting existing DIL materials rather than developing them from scratch. Several resources for materials include:

- New England e-Science Portal – Data Literacy section (<http://esciencelibrary.umassmed.edu/data-literacy>)
- Data Information Literacy Case Study Directory (<http://docs.lib.purdue.edu/dilcs/>)
- Teaching with Data (<http://www.teachingwithdata.org/>)

Finally, develop relevant examples that will resonate with students. We have found that using common everyday examples of data, ethical challenges, and visualizations can help students grasp data concepts, particularly when they have no previous experience in the discipline. It can often be helpful to start the discussions on a personal level, then transition to discipline specific issues.

Conclusion

Researchers in academia, employees at a manufacturing firm, and community health workers will all be tasked with using data to make decisions in their personal and professional lives. The

21st century worker must be fluent in an increasingly complex and unstructured information world. The ultimate goal of data information literacy is to enable students to become lifelong learners who actively participate in the use and creation of information. To that end, these case studies examine how DIL can help students achieve both academic and professional goals. In writing up these cases, we were able to describe a tailored yet common approach for integrating DIL. We believe these cases offer useful strategies for identifying opportunities and initiating a programmatic approach to DIL instruction. We look forward to learning how other librarians and disciplines are incorporating DIL into the classroom.

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