Preliminary Investigation (PI-0285)

Caltrans Division of Research, Innovation and System Information

Data Literacy Training Assessment

Requested by
Chad Baker, Geospatial Data Officer

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Executive Summary

Background

The need for data literacy—the ability to interpret and communicate data in context—is increasing as organizational growth becomes more and more data-driven. As part of its efforts to maintain a data-literate workforce, California Department of Transportation (Caltrans) launched the Enterprise Data and Geospatial Governance Program that addresses the needs of people, process and technology. Among the goals of this program is to develop and implement a data literacy training program within Caltrans that will ensure a properly trained workforce of data stewards, data custodians and data analysts who effectively manage the agency's data assets and turn data into information that drives decision-making.

To inform the development of a data literacy training program, Caltrans sought information about the practices and educational approaches used by state transportation departments and other agencies. To assist Caltrans in this information-gathering effort, CTC & Associates surveyed two groups:

- *State departments of transportation (DOTs)*. Members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Data Management and Analytics.
- *California metropolitan planning organizations (MPOs)*. Representatives from a selected group of California MPOs.

Experts in data literacy were also consulted for their insight into developing and implementing these programs. A literature search supplemented the findings of the survey and consultations with experts.

Summary of Findings

This Preliminary Investigation gathered information in four areas:

- Survey of practice.
- Consultation with experts.
- Data literacy programs and guidance.
- Related research and resources.

Survey of Practice

Ten agencies—nine state transportation agencies and one MPO—responded to the survey:

- Florida DOT.
- Minnesota DOT.
- Nebraska DOT.
- Nevada DOT.
- New Hampshire DOT.
- New York State DOT.
- San Diego Association of Governments (SANDAG).
- Oregon DOT.
- Vermont Agency of Transportation.
- Wisconsin DOT.

None of these agencies have implemented a data literacy training program. Eight agencies, including SANDAG, are considering implementing a training program. New Hampshire DOT has

committed resources to other technology initiatives and is not currently planning to implement a data literacy training program. The respondent from Florida DOT's Transportation Data and Analytics Office described the training program created for the Roadway Characteristics Inventory, which collects data for road inventory and asset management. Survey responses from Florida DOT are presented in a supplement to this report.

Efforts to Implement Data Literacy Training

Agencies from seven states—Minnesota, Nebraska, Nevada, New York, Oregon, Vermont and Wisconsin—and SANDAG are considering implementing a data literacy training program:

Program Development Underway
Two of the eight agencies—Nevada and Oregon DOTs—are currently developing data literacy training:

- Nevada DOT is launching a data and analytics program, and data literacy will be part of the initiative.
- Oregon DOT is developing data literacy learning modules.

Use of Existing Data-Related Training
Three agencies considering a data literacy training program—Minnesota DOT, Nebraska DOT and SANDAG—described current practices:

- Minnesota DOT has four mandatory data-related trainings with overlapping content. The agency would like to implement a comprehensive, phased data literacy training program with modules targeted to specific audiences. Synthesizing the current trainings into one comprehensive approach will require "a major change" to the required curriculum and significant coordination among multiple stakeholders.
- Nebraska DOT has created videos that explain and demonstrate business intelligence, data governance, glossaries and catalogs. Currently links to these videos are sent to agency staff via email.
- SANDAG currently provides a high-level introduction to agency and key program area staff as part of a data governance project that was funded by a Caltrans planning grant. As governance practices are implemented agencywide, SANDAG plans to follow up with a formal training program.

Other Practices

- The benefits of a data literacy program and data-based decision-making are apparent to New York State DOT as data availability increases.
- Vermont Agency of Transportation recognizes the need for agencywide data literacy training, particularly when new staff report difficulties locating data and data sources.
- Wisconsin DOT is reinvigorating its data stewardship program and helping business area data stewards understand general data governance concepts and roles.

Consultation With Experts

Two public agency representatives were contacted for their insight and experience with data literacy training programs:

- Penelope Weinberger, AASHTO Committee on Data Management and Analytics.
- David Sanabria, Office of Systems Integration, California Health and Human Services.

Inquiries to these experts sought information about the approach used for data literacy training programs (for example, existing training, customized training, or both existing and customized training); the results of implementing these programs in organizations; and lessons learned from implementing these programs. In addition to these consultations, users of the Caldata Slack channel were queried for information about data literacy training programs.

AASHTO Committee on Data Management and Analytics
Penelope Weinberger is the transportation data program manager of Policy and Government Relations at AASHTO. She is also the liaison for the AASHTO Committee on Data Management and Analytics, whose members received the survey for this Preliminary Investigation. Weinberger contacted members of the AASHTO Chief Data Officer Peer Group and asked them to provide information about their data literacy training program practices. Peer group members did not respond to this inquiry.

California Office of Systems Integration
David Sanabria is data architect and chief data strategist in the Office of Systems Integration at California Health and Human Services. He provided an overview of data literacy efforts and the value of data, emphasizing the importance of data literacy as an organizational or cultural change, not simply skills training. Organizational leaders can champion this change, Sanabria said, by approaching data as an asset that leads to improved services and outcomes.

A data-literate culture uses quantitative or qualitative data in meaningful ways to justify decisions that improve lives, reduce risk and reduce costs. Data stewardship is the responsibility of government agencies, he said, which measures outcomes and makes decisions on behalf of citizens. Everyone can learn to use data specific to their role, he added, but it requires developing critical thinking skills.

Practices that agencies can use to begin this cultural shift begin with ensuring that data is valued at an organization's executive level. Leaders must communicate the benefits of data to create and sustain a desire for change among staff. Policies or technical directives should be developed that require employees to share data through an agency portal. Generating awareness of the change management process and using data to drive action are also necessary. In addition to these practices, Sanabria recommended several resources for developing data literacy training and other data-related issues (see page 12).

Caldata Slack Channel
None of the users of the Caldata Slack channel responded to inquiries about data literacy training programs.

Data Literacy Programs and Guidance

Key programs are presented that promote data fluency through online learning platforms and in-person training, including:

- DataCamp.
- Data Literacy Project.
- Qlik Data Literacy Program.
- Federal Highway Administration National Highway Institute.

A 2020 online resource presents a roadmap for creating a data literacy program and a 2017 competency matrix for assessing data management skills. Also highlighted is a 2020 edition of a Special Libraries Association journal that is devoted to data literacy. The issue addresses the seven core data literacy competencies for employees and reviews online resources for learning data literacy skills and concepts.

Following these program descriptions is a sampling of data literacy courses offered through these and other data education or professional education organizations (beginning on page 17). Each data literacy course presented in this section briefly summarizes the course and expected outcomes, target audience, training delivery method, length of the course and cost. Program assessments, certifications and other course-related details are provided when available. Table ES1 summarizes course offerings.

Table ES1. Sampling of Data-Related Course Offerings

Training Organization	Course Title	Course Description
Coursera	Data Management and Visualization	Use of powerful data analysis tools to manage and visualize data
Cprime Learning	Data Literacy for Business Professionals	Fundamental data skills for the workforce
Data Literacy LLC	Data Literacy Fundamentals	• Introductory skills for beginners • Additional data literacy coursework available
DataSF	Data Usability	Excel tools and formulas to test data for analysis readiness
edX Inc.	Data Literacy Foundations	Critical thinking skills for working with data, legal and ethical issues associated with data, and data analysis tools and techniques
Kubicle	Data Literacy: Understanding Data	Nontechnical principles of understanding and working with data
LinkedIn Learning	Data Visualization, Story-telling and Information Design: A Lesson and Listen Series	An ongoing series (currently 17 modules) that explores key themes in data visualization, story-telling and information design
National Highway Institute	Safety Data and Analysis Fundamentals Training	Individual learning tracks for data analysts, data collectors, project/program managers and safety advocates
	Data Archiving and Analytics for Planning, Operations and Safety	Benefits of creating an open and accessible data archive of agency data
	The Role of Data in Transportation Performance Management	Purpose and benefits of accurate and current relevant data in transportation performance management (TPM) activities
	Highway Performance Monitoring System (HPMS)	• Introduction to HPMS • Making the Connection Between HPMS Data Items and TPM • HPMS: Concept, Data Collection and Reporting Requirements

Training Organization	Course Title	Course Description
QlikTech International	Data Literacy Program	Courses offered in five topic areas: • Overview of data literacy • Data fundamentals • Foundational analytics • Data-informed decision-making • Advanced analytics
University of California, Davis	Data Analytics Boot Camp	24-week session that teaches the knowledge and skills to conduct analytics of real-world problems.

Related Research and Resources

A literature search of domestic and international resources produced publications and other materials related to data literacy training programs, including international guidance and data literacy efforts underway in California.

California Resources

DataSF, the initiative to empower San Francisco city and county employees to use area data, is highlighted. Citations include the Data Academy course catalog, which describes tool- and skill-focused training in numerous data-related topics, including data analysis, visualization and management; information design; and process improvement. Collections of resources, including a data coordinator guidebook and a data inventory template, are also described. Additional resources evaluate DataSF's impact on city departments, presenting performance metrics and the academy's overall effectiveness.

Other Domestic Research and Guidance

Journal articles and online resources address the need for developing data literacy in organizations, promoting buy-in from executive leadership and providing step-by-step measures for implementation. A 2020 journal article recommends practical solutions for boosting data literacy capabilities, and a 1999 journal article forecasts the use of data in organizational decision-making, describing a curriculum that crosses business disciplines and uses data in real-world applications. Strategies for building a data-literate culture are presented in several 2019 online articles, and a U.S. Department of Commerce web site presents multiple practices and action steps for building and promoting a data-literate culture "to fully leverage the value of federal data for mission, service and the public good." Additional guidance from library and data science journals emphasizes the need to offer curriculum in higher education that prepares individuals for joining a data-literate workforce.

International Resources

A 2015 report from Dalhousie University provides a wealth of strategies, best practices and resources for developing data literacy education. Several Canadian citations also address this topic, including a June 2020 online resource that discusses novel approaches to data literacy programs; a 2019 Statistics Canada report that examines how to measure data literacy in public service; and information about the Digital Academy, which was established by the Canada School of Public Service. Two data literacy programs are also featured: School of Data, "a global network committed to advancing data literacy in civil society," and Open Data Institute,

which promotes “the value of open data and [advocates] for the innovative use of open data to affect positive change across the globe.”

Related Resources

Business intelligence and other data-related topics are discussed in this section, which includes additional resources from QlikTech International and a 2019 blog post that presents an overview of the top 15 business intelligence tools. Also included is a 2020 National Cooperative Highway Research Program (NCHRP) report that examines data management and open data access to help state DOTs and other organizations that receive transportation-related federal funds to comply with federal requirements for publishing and communicating research, and a 2020 tutorial that describes essential concepts of data warehousing.

Gaps in Findings

State DOT and California MPO response to the survey was very limited. In addition, none of the responding agencies have implemented a data literacy training program and only two are actively implementing a program. The consultations with subject matter experts also produced little information that could be applied to program development and implementation. Caltrans could benefit from additional inquiries to nonresponding state transportation agencies and California MPOs to possibly identify policies and practices related to these programs.

Next Steps

Moving forward, Caltrans could consider:

- Engaging with responding agencies that are currently implementing or considering implementing data literacy training programs, including:
    - Nevada DOT and Oregon DOT, which are actively developing or implementing data literacy training.
    - Minnesota DOT, Nebraska DOT and SANDAG, which are taking preliminary steps to implement a data literacy training program.
- Contacting nonresponding state DOTs and California MPOs for more targeted information.
- Reaching out to the subject matter experts consulted for this Preliminary Investigation, specifically:
    - David Sanabria, data architect and chief data strategist at California Office of Systems Integration, for the results of the data literacy survey that was recently conducted across California Health and Human Services. The agency has compiled the results of the survey in an executive summary.
    - AASHTO Chief Data Officer Peer Group, recommended by Penelope Weinberger, liaison for the AASHTO Committee on Data Management and Analytics, for knowledge of and experience with data literacy training programs among committee members.
- Examining the numerous data literacy programs and course offerings presented in this report for guidance and research related to the development and implementation of data literacy training.
- Reviewing the publications and resources identified in the literature search for additional guidance and research.

Detailed Findings

Background

Research suggests that 50% of organizations lack sufficient artificial intelligence and data literacy skills to achieve business value. The importance of data literacy—the ability to interpret and communicate data in context—is becoming more and more apparent as growth within organizations becomes increasingly driven by data. To address the challenges related to data literacy, California Department of Transportation (Caltrans) has initiated efforts to develop an enterprisewide data governance program that addresses three fundamental aspects: people, process and technology. These efforts include:

- Establishing a governance council and board for the agency's Enterprise Data and Geospatial Governance Program.
- Adopting standard governance definitions and data stewardship roles and responsibilities.
- Adopting a set of standard templates to document data sets and systems.
- Adopting a quality management plan template.
- Making other improvements informed, in part, by a departmentwide capability/maturity assessment.

In 2019, the Enterprise Data and Geospatial Governance Program launched a three-year action plan that included developing and implementing a Caltrans data literacy training program to ensure the agency retains a properly trained workforce of data stewards, data custodians and data analysts who have the understanding and skills to effectively manage the agency's data assets and turn data into information to drive decision-making. To inform the development of an enterprisewide training program, Caltrans is interested in learning about the practices used by other agencies, including the educational approaches adopted such as:

- Using available training.
- Developing customized training.
- Implementing a hybrid approach that leverages available training supplemented by limited customized training to address agency-specific topics.

To assist Caltrans in this information-gathering effort, CTC & Associates conducted an online survey of state departments of transportation (DOTs) and a selected group of California metropolitan planning organizations (MPOs) about their experience with data literacy training programs. The survey sought general information about these programs as well as best management practices and efforts to measure specific impacts of the training program.
In addition to the survey, experts in data literacy were consulted for information about efforts to implement these programs on an enterprise scale and lessons learned. To supplement the survey and consultation findings, a literature search of domestic and international in-progress and completed research examined data-related guidance and research, and current data literacy training programs and courses. This Preliminary Investigation presents the findings from these efforts in the following topic areas:

- Survey of practice.
- Consultation with experts.
- Data literacy programs and guidance.
- Related research and resources.

Survey of Practice

Survey Approach

To gather information about the practices used by other public agencies to develop and implement data literacy training programs, CTC & Associates distributed an online survey to:

State DOTs. The survey was sent to members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Data Management and Analytics. This committee's membership is national in scope and includes representatives from state transportation agencies in all 50 states and the District of Columbia.

California MPOs. The survey was also sent to representatives of the following agencies:

- Metropolitan Transportation Commission.
- Sacramento Area Council of Governments.
- San Diego Association of Governments (SANDAG).
- Southern California Association of Governments.

Survey questions are provided in Appendix A. The full text of survey responses is presented in a supplement to this report.

Summary of Survey Results

Nine state transportation agencies responded to the survey:

- Florida.
- Minnesota.
- Nebraska.
- Nevada.
- New Hampshire.
- New York.
- Oregon.
- Vermont.
- Wisconsin.

One of the four MPOs—SANDAG—also responded.

None of the 10 agencies participating in the survey have implemented a data literacy training program. SANDAG and transportation agencies from seven states—Minnesota, Nebraska, Nevada, New York, Oregon, Vermont and Wisconsin—are considering implementing a training program. New Hampshire DOT does not have and is not planning to implement a data literacy training program; the agency is currently pursuing multiple technology initiatives and does not have sufficient resources for data literacy. The respondent from Florida DOT's Transportation Data and Analytics Office described the training program created for the Roadway Characteristics Inventory to support the data collection needs for road inventory and asset management.

Survey responses from Florida DOT are presented in a supplement to this report. Responses from the eight agencies that are considering implementing a data literacy training program are summarized below.

Efforts to Implement a Data Literacy Training Program

Two of the eight agencies—Nevada DOT and Oregon DOT—are currently developing data literacy training. Nevada DOT is launching a data and analytics program, and data literacy will be part of the initiative. Oregon DOT is developing data literacy learning modules.

Minnesota DOT, Nebraska DOT and SANDAG are also considering implementing a data literacy training program and provided information about their efforts:

- Minnesota DOT would like to implement a phased, comprehensive data literacy training program targeted to specific audiences. For example, all employees would take an initial fundamentals module; office directors and employees who work closely with data would also take a second module; and data and application stewards with assigned governance roles would take a third module. However, transitioning from its existing, "siloed" trainings to this phased approach is challenging. The agency's current data-related training curriculum has four trainings with overlapping content, and each training is mandatory. Replacing these four trainings with a single training that covers all existing content plus additional content would require "a major change" to the required curriculum and significant coordination of effort among multiple stakeholders.
- Although Nebraska DOT does not have an official training program, it currently sends emails to agency staff with links to videos that explain and demonstrate business intelligence, data governance, glossaries and catalogs.
- As part of a data governance project that was funded through a Caltrans planning grant, SANDAG provided a high-level introduction to the agency and key program area staff. The agency plans to follow up with a formal training program as it implements data governance agencywide. A final report and data governance manual were submitted as part of this project; in addition, SANDAG funded tasks that developed a data supply chain management roadmap, data catalog and database architecture. These documents are provided as supplements to this report.

With an increase in data availability, New York State DOT acknowledges that it would benefit from a data literacy program and data-based decision-making. In Vermont, some newer staff has expressed concerns about locating data and data sources, which has contributed to the agency's interest in agencywide data literacy training. Wisconsin DOT is currently trying to reinvigorate its data stewardship program and help business area data stewards understand general data governance concepts and their roles.

Table 1 summarizes survey responses by topic area.

Table 1. Current Data Literacy Training Activities

Factor	State/Agency	Description
Program Development Underway	Nevada, Oregon	*Nevada*. Launch of data and analytics program underway (includes data literacy). *Oregon*. Development of data literacy learning modules.

Use of Existing Data-Related Training	Minnesota, Nebraska, SANDAG	*Minnesota*:
		• Currently four mandatory trainings with overlapping content.
		• Plans for new, comprehensive program:
		  ○ Move from four "siloed" trainings to a curriculum targeted to specific employees:
		  ▪ Module 1: Fundamentals, for all employees.
		  ▪ Module 2: Directors/others who work closely with data.
		  ▪ Module 3: Data/application stewards with assigned governance responsibilities.
		  ○ Challenges:
		  ▪ Replacing four trainings with one in-depth training.
		  ▪ Obtaining buy-in from multiple stakeholders.
		
		Nebraska. Access to videos about business intelligence, data governance, glossaries and catalogs is provided to agency staff.
		
		SANDAG:
		• High-level introduction to agency and key program area staff provided through a data governance project (funded by Caltrans planning grant).
		• Plans for a formal training program as governance is implemented agencywide.

Other	New York, Vermont, Wisconsin	*New York*. Data literacy program would benefit department by improving decision-making based on data analysis. *Vermont*. Need for enterprisewide program expressed by some new staff unable to locate data and data sources. *Wisconsin*. Agency reinvigorating its data stewardship program and helping business area data stewards understand general data governance concepts and roles.

Consultation With Experts

The following experts and resources were contacted for information about data literacy training programs:

- Penelope Weinberger, AASHTO Committee on Data Management and Analytics.
- David Sanabria, California Office of Systems Integration.
- Caldata Slack channel.

Inquiries were focused on obtaining information about the approach used for data literacy training programs, such as existing training, customized training or a hybrid model that used both available and customized training; the results of implementing these programs in organizations; and lessons learned from implementing these programs.

The posting on the Caldata Slack channel did not receive responses from other users. Below are summaries of email and phone conversations with the subject matter experts from AASHTO and the California Office of Systems Integration.

AASHTO Committee on Data Management and Analytics

Contact: Penelope Weinberger, Transportation Data Program Manager, Policy and Government Relations, American Association of State Highway and Transportation Officials, pweinberger@aashto.org.

Penelope Weinberger is the liaison for the AASHTO Committee on Data Management and Analytics, whose members received the survey for this Preliminary Investigation. She contacted members of the AASHTO Chief Data Officer Peer Group to obtain information about members' data literacy training program practices. The members did not respond to inquiries.

California Office of Systems Integration

Contact: David Sanabria, Data Architect, Chief Data Strategist, Office of Systems Integration, California Health and Human Services, david.sanabria@osi.ca.gov.

David Sanabria is data architect and chief data strategist in the Office of Systems Integration, California Health and Human Services, which is "2.5 years into a journey of discovery and change management specific to data literacy." Sanabria emphasized the value of data and data literacy in operations, and encouraged leadership to consider data literacy as an organizational or cultural change, not simply skills training.

Change management that is specific to data literacy begins with changing the mindset that data-related activities are the responsibility of information technology departments, he said. Executives must champion the change, shifting expectations related to data from being a burden to an asset that provides better services and delivers better outcomes.

According to Sanabria, a data-literate culture focuses on outcomes and uses quantitative or qualitative data in meaningful ways to justify decisions that improve lives, reduce risk and reduce costs. Data stewardship is the responsibility of government agencies, which make decisions on behalf of citizens. Government employees are obligated to understand and communicate with data; for example, when reviewing vendor proposals or shaping regulations,

employees must gather and interpret data to measure outcomes. Everyone can learn to use data specific to their role, he added, but it requires developing critical thinking skills.

When asked about best practices, Sanabria reiterated that agencies can begin this cultural shift by ensuring that data is valued at an organization's executive level. Leaders must champion the change, communicating the benefits of data to create and sustain a desire for change among staff. Developing policies or technical directives that require employees to share data through an agency portal is an effective practice. Also effective are generating awareness of the change management process and using data to drive action.

A data literacy survey was recently conducted across California Health and Human Services. Sanabria noted that the agency has compiled the results of the survey in an executive summary, which was unavailable at the time of publication of this Preliminary Investigation.

Related Resources

Among the resources that Sanabria recommended for developing data literacy training are Strategies and Best Practices for Data Literacy Education synthesis report (see page 41) and The "Know Data" page (https://bit.ly/know-data), a GitHub page that he maintains to address various data-related topics, such as ethics in data, data operations, data strategies and data literacy. Publications on that page include:

Working Group on Education: Digital Skills for Life and Work, UNESCO, September 2017.
http://bit.ly/2WRNnN0
From the introduction: While digital skills education and training has evolved over the past 20 years, the quality and effectiveness of its provision remain inconsistent. Pronounced inequalities and disparities exist in terms of individuals' digital skills and competencies within communities, countries and regions. Reconciling these gaps will require more than technology alone. Holistic approaches—encompassing policy, implementation, funding and partnership—are needed to ensure that all learners have opportunities to cultivate relevant digital skills.

"Building a Unified Data and Information Literacy Program: A Collaborative Approach to Instruction," Andrew Johnson and Megan Bresnahan, *Library Instruction West*, July 2014.
https://figshare.com/articles/Building_a_unified_data_and_information_literacy_program_A_collaborative_approach_to_instruction/1119760
From the abstract: As information literacy needs of graduate students change and expand, library initiatives should respond with approaches that align holistically with users' perspectives by incorporating areas like research data into existing information literacy instruction programs. This presentation will provide a model for subject and instruction librarians to use to promote their skills and expertise within their organizations' existing or yet to be developed research data efforts. For institutions that already have positions dedicated to research data, subject and instruction librarians can learn how to market their value in enhancing research data instruction. At libraries where research data services are nascent or still under consideration, librarians can leverage the examples provided in this presentation to promote expansion or adoption of these efforts. Drawing from experiences at the presenters' institution, this presentation provides support for combining information literacy and research data into a comprehensive and coherent instruction program.

Data Literacy Programs and Guidance

Data Literacy Programs

DataCamp, 2020.
http://www.datacamp.com/
This online learning platform offers numerous data science courses, including data literacy fundamentals and data skills for business.

The Data Literacy Foundation, undated.
https://dataliteracyfoundation.org/
Toolkit: https://dataliteracyfoundation.org/toolkit
Podcast: https://dataliterates.com/
Working with nonprofits and foundations, this organization seeks to enhance data fluency by creating data literacy strategies, building data-oriented capabilities and sharing best practices. The organization has developed a toolkit for creating a data literacy program. Although the toolkit is currently not available for download, it can be viewed at the site. *From the web site*:

> Using our **D**iscovery, **S**trategy, **D**esign, **D**elivery methodology and the tools we provide, you will be able to craft a program that identifies, confronts and solves the issues with [d]ata [l]iteracy in your organization. The toolkit includes:
>
> - The 5 Cs of Data Literacy.
> - The Data Literacy Canvas.
> - The Data Maturity Assessment.
> - The Analytics Maturity Assessment...and much more.

Also available at the site is "Data Literates," the foundation's podcast, which provides "practical and actionable solutions that enable a [d]ata [l]iterate [o]rganization."

Data Literacy Project, undated.
https://thedataliteracyproject.org/learn
From the web site:

> Launched by the global data analytics leader Qlik, the Data Literacy Project includes founding partners Accenture, Cognizant, Experian, Pluralsight, the Chartered Institute of Marketing, and Data to the People—along with academic thought leaders. Together we aim to ignite discussion and develop the tools we need to shape a successful, data literate society.

Note: The Data Literacy Project site provides access to QlikTech International's Data Literacy Program e-learning courses (see page 20) and other data literacy reports and resources.

Related Resource:

> **"World-First Comprehensive Certification for Data Literacy Launched,"** News Post, Data Literacy Project, May 2019.
> https://thedataliteracyproject.org/posts/the-data-literacy-project-partners-with-qlik-to-launch-world-first-comprehensive-certification-for-data-literacy
> *From the web site*: The Data Literacy Project, the community dedicated to making society fluent in data, introduced the first globally recognized certification that will enable individuals

to document and demonstrate their data literacy skills. This free certification has been developed by leading academics and data literacy specialists at Qlik, supporting the company's role in the Data Literacy Project's mission to enable individuals at every stage in their data literacy journey.

Qlik Data Literacy Program: Data Literacy Training, Consulting and Resources, QlikTech International, 2020.
https://www.qlik.com/us/services/data-literacy-program
Qlik offers many free online courses in data literacy (see page 20) and other subject areas. Courses are primarily online self-paced modules but some courses are instructor-led. Data literacy and data analytics certifications are available. *From the web site*:

> The Data Literacy Program is designed to empower your entire workforce to use data effectively—regardless of role or skill. This industry-leading program offers comprehensive learning resources and consulting services to build data literacy skills across your organization.

Related Resource:

> **Developing a Data Literate Workforce**, Jordan Morrow, QlikTech International, July 2018.
> https://www.qlik.com/us/-/media/files/training/global-us/qlik-education-data-literacy-program-strategy-and-framework.pdf
> *From the whitepaper*: This strategy and framework presents a six-step approach based on best practices for designing, developing and implementing a successful data literacy program across your organization. The results will be reflected in a sharper competitive edge in every part of your business and a loyal workforce energized and empowered by your investment in their professional development.
>
> This strategy and framework has been designed for adoption of data literacy at the enterprise level. Ideally, data literacy initiatives should start at the level of the [c]hief [d]ata [o]fficer (CDO), found in the enterprise C-suite. In their role, the CDO of an organization should be the leader and greatest advocate of the data literacy initiative, ensuring full adoption and buy-in. While data is at the core of their mandate, data literacy needs to be embedded into what they do, as it's often seen as [one] of the major stumbling blocks for successful data programs.

edX, 2020.
https://www.edx.org
Data science courses: https://www.edx.org/course/subject/data-science
Business intelligence courses: https://www.edx.org/learn/business-intelligence
Data analytics for business: https://business.edx.org/elearning/courses/data-analytics)
edX offers many courses in a wide range of data-related topics, including data science, business intelligence and data analytics for business (see page 30 for sample classes). *From the web site*:

> The mission:
>
> - Increase access to high-quality education for everyone, everywhere.
> - Enhance teaching and learning on campus and online.
> - Advance teaching and learning through research.

National Highway Institute, Federal Highway Administration, undated.
https://www.nhi.fhwa.dot.gov/home.aspx
Course catalog: https://www.nhi.fhwa.dot.gov/downloads/catalog/nhicoursecatalog.pdf
From the web site:

> The National Highway Institute (NHI) provides technical training to the highway transportation workforce to build skills and enhance job performance to improve the conditions and safety of our nation['s] roads, highways, and bridges. As part of Federal Highway Administration's (FHWA) Office of Technical Services (OTS), NHI courses complement the targeted training and technical assistance of FHWA program offices, Resource Center, and Local and Tribal Technical Assistance Programs (LTAP/TTAP).

NHI's web site allows the reader to generate a custom course catalog based on desired delivery format (instructor-led, web-based or web-conference) and any number of 18 program areas (see page 22 for sample classes).

Tuva Labs, undated.
https://tuvadata.com/
From the web site:

> Tuva is on a mission to build a strong foundation in data literacy from the classroom to the boardroom. We are bringing together research, pedagogy, and technology to develop rigorous instructional and assessment solutions that are used in thousands of schools, districts, enterprises, and government agencies around the world. … Tuva empowers businesses and government agencies to build organizational data literacy and scale the value of data and analytics.

Course content on the web site is focused on K-12 instruction. Government agencies and business enterprises are given access to Gartner Research reports and to Tuva's data literacy diagnostic assessment tool, which:

- Measures employees' ability to explore, interpret and reason with data and analytics.
- Determines how employees use data and analytics to drive better business decisions.
- Implements industry- and role-based data and analytics scenarios and tasks.

Guidance for Program Development

"A Roadmap for Creating a Data Literacy Program: A Guide for HR, L&D [Learning & Development] and Data Leaders," QuantHub, 2020.
https://quanthub.com/data-literacy-program/
This online article describes why data literacy programs are needed and the skills employees should develop, and provides a "roadmap for establishing data literacy." (QuantHub's web site indicates it is the "industry expert" in "vetting and developing data scientists and data engineers.")

"Data Literacy," *Information Outlook: The Magazine of the Special Libraries Association*, Vol. 24, Issue 1, January/February 2020.
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1240&context=lib_fsdocs
The entire issue of this publication geared to special librarians is devoted to data literacy. Among the topics addressed in this issue are seven core data literacy competencies for employees and a review of online resources to learn data literacy skills and concepts.

Related Resource:

"Adding Data Literacy Skills to Your Toolkit," Megan R. Sapp Nelson, *Information Outlook: The Magazine of the Special Libraries Association*, Vol. 24, Issue 1, page 10-11, January/February 2020.
https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1240&context=lib_fsdocs
From the abstract: Developing selected skills in data literacy and management can help librarians make a substantial contribution to the stability and long-term preservation of data at their organization.

"A Pilot Competency Matrix for Data Management Skills: A Step Toward the Development of Systematic Data Information Literacy Programs," Megan R. Sapp Nelson, *Journal of eScience Librarianship*, Vol. 6, Issue 1, pages 1-11, 2017.
https://escholarship.umassmed.edu/cgi/viewcontent.cgi?article=1096&context=jeslib
From the abstract: Initial work in identifying data management or data information literacy skills generally went as far as identifying a list of proposed competencies without further differentiation between those competencies, whether by discipline, complexity or use case. This article describes a significant innovation upon existing competencies by identifying a scaffolding (built upon existing competencies) that moves students progressively from undergraduate training through post-graduate coursework and research to post-doctoral work and into the early years of data stewardship. The scaffolding ties together existing research that has been completed in research data management skills and data information literacy with research into the outcomes that are desirable for individuals to present in data management at each of the levels of education. Competencies are aligned according to application (personal, team, research enterprise) in such a way that the skills attained at the undergraduate level give students moving on to graduate work greater familiarity with data management and therefore greater likelihood of success at the graduate and then post-graduate and data steward levels.

Note: Pages 10 and 11 of this journal article provide a comprehensive list of references that may include other publications of interest to the panel. Appendix 1, Crosswalk of Five Data Literacy Competency Lists, available at https://escholarship.umassmed.edu/cgi/viewcontent.cgi?filename=4&article=1096&context=jeslib&type=additional, provides a matrix of five competency proposals.

The author notes that the crosswalk "shows that the competencies mirror each other in the need to teach learners about the form and format of data and databases, the management of that data, the curation and reuse of data, and the metadata used to describe that data. At least three of the five agree in teaching the cultures of practice around data use, the preservation of data, the analysis of data, the visualization of data, and the ethics of data production and use. Overall, there is strong consensus in the literature of competencies regarding the major themes that should be addressed in data education."

Data Literacy Courses

Below is a sampling of data literacy courses presented in three categories:

- Data education organizations.
- National Highway Institute.
- Professional education organizations.

Each course description includes a brief summary of the course and expected outcomes, target audience, training delivery method, length of the course and cost. When available, information about program assessments, certifications and other course-related details are provided.

Data Education Organizations

Below are data-related courses available from:

- Data Literacy LLC.
- DataSF.
- QlikTech International.

Data Literacy LLC

Data Literacy Fundamentals
https://dataliteracy.com/data-literacy-fundamentals/

Public or Private Sector Training	Private sector
Target Audience	Anyone who would like to build a firm foundation of data literacy.
Course Content	• The 1 overall goal of data. • The 2 systems of human thinking involved. • The 3 areas of life where data matters. • The 4 different data scale types. • The 5 forms of data analysis. • The 6 ways of displaying data. • The 7 groups of data activities teams carry out. • The 8 questions to ask your data upfront.
Course Description	*From the web site*: Data Literacy Fundamentals is for anyone who is just getting started with data and who wants to feel more confident in their understanding of what data is, what it isn't and what it's used for. Even those who are "data-phobic" are welcomed to sign up and take this class. No experience is required, and you don't need to be familiar with any software programs other than how to navigate around a modern browser.
Training Delivery Method	Self-paced online
Typical Length of Class	Modules: 2 to 14 minutes
Total Number of Courses Offered	8 courses with 34 modules
Total Overall Program Hours	3 hours, 40 minutes
Training Cost	• First course: Free. • All 8 courses: $399 (team pricing available)

Related Courses:

- Data Literacy I: How to Read and Interpret Data Visualization.
- Data Literacy II: How to Explore and Communicate Data.
- Data Literacy Foundations: Understanding the Power and Value of Data.

Related Resource:

Data Literacy LLC, undated.
https://dataliteracy.com/about-us/
From the web site: At Data Literacy LLC, our mission is to help people learn the language of data. The vast majority of people in the world today do not receive a formal education that adequately prepares them for the level of data fluency required of them in their careers and by their communities. As a result, many are being left behind by the transition to data-driven dialogues and decisions all around them, and they're seeking ways to break down the language barrier that's preventing them from participating. Others are looking for ways to build upon their current level of proficiency to contribute in an even more meaningful way.

DataSF

Data Usability
https://datasf.org/academy/data-usability/

Public or Private Sector Training	Public sector
Target Audience	City and county officials

Course Content	• Functions in Excel to clean and prepare data for analysis:
	  ○ Use Paste-Transpose and SEARCH and FIND functions to create categorical variables.
	  ○ Create fiscal years from dates.
	  ○ Prepare addresses using CONCATENATE.
	  ○ Create flexible lookups using INDEX and MATCH.
	• New mindsets for approaching data preparation and cleaning.

Course Description	*From the web site*: This classroom based workshop will go over how to make certain data set design decisions that will make your reporting life much easier, hopefully reducing repetitive asks for data and interpretation. This is a methods course that will primarily use tools and formulas in Excel to help you test your data for analysis readiness. *Course prerequisites*: • Experience navigating in an Excel worksheet. • Access to Excel 2010 or 2013 at a workstation.
Training Delivery Method	Classroom
Typical Length of Class	2 hours
Training Cost	Free to San Francisco city and county employees (with a supervisor's approval)

Note: Additional information about DataSF data literacy courses begins on page 35.

Related Resource:

DataSF, Office of Chief Data Officer, City and County of San Francisco, undated.
https://datasf.org/
Data SF promotes "programs, services and initiatives related to data sharing, data analytics and data science. … Our mission is to empower use of the City and County of San Francisco's data. Our core product is SF OpenData, the official open data portal."

QlikTech International

Data Literacy Program
https://learning.qlik.com/mod/page/view.php?id=24704
Below is an overview of Qlik's Data Literacy Program courses. As noted in "Course Content" below, the program offers courses in five topic areas: overview of data literacy, data fundamentals, foundational analytics, data-informed decision-making and advanced analytics. Following this overview is a sampling of courses offered in three topic areas.

Note: Data Literacy Project also provides access to this program and courses through its Data Literacy Project e-learning offerings: https://thedataliteracyproject.org/learn.

Public or Private Sector Training	Private sector
Target Audience	Anyone

Course Content	Program offers courses in five topic areas:
	• Overview of Data Literacy:
	  ○ Analytics
	  ○ A Culture of Data Literacy
	  ○ Data Literacy Adoption
	  ○ Data Storytelling
	• Data Fundamentals:
	  ○ Understanding Data
	  ○ Understanding Aggregations
	  ○ Understanding Distributions
	• Foundational Analytics:
	  ○ Introduction to Data Science
	  ○ Understanding Signal and Noise
	  ○ Correlation and Causation
	  ○ Confidence Intervals
	  ○ Analytical A/B Testing
	  ○ Hypothesis Testing
	  ○ Design of Experiments
	  ○ Simple Linear Regression Analysis
	• Data-Informed Decision-Making:
	  ○ Introduction to Data-Informed Decision-Making
	  ○ Data-Informed Decision-Making Framework
	  ○ Decision-Making Analytic Techniques
	• Advanced Analytics:
	  ○ Decision Tree Analysis
	  ○ Advanced Analytics Integration With Qlik Sense
	  ○ Multiple Linear Regression Analysis

Training Delivery Method	Online
Typical Length of Class	11 to 39 minutes
Total Number of Courses Offered	20
Training Cost	Free
Program Assessment/References	Assessments and certifications available for some courses.

Sample courses in this program:

A Culture of Data Literacy

https://learning.qlik.com/course/view.php?id=723

Public or Private Sector Training	Private sector
Target Audience	Anyone
Course Content	• Definition of data literacy • Definition of a data literacy culture • How proper culture influences an organization • Steps to ensure organizations have the proper culture in place
Course Description	*From the web site*: This course is designed to help users gain an understanding of data literacy and culture, learn about these concepts and their roles in today's world of data, and help them understand why this information is important in the world today.
Training Delivery Method	Interactive video
Typical Length of Class	29 minutes
Training Cost	Free

Understanding Data

https://learning.qlik.com/course/view.php?id=382

Public or Private Sector Training	Private sector
Target Audience	Business professionals
Course Content	• Understanding of data • Types and attributes of data • Importance of data in analytics
Course Description	*From the web site*: This course is designed to help users gain an understanding of data, learn about different types and attributes of data, and help them understand why this information is important in the world today.
Training Delivery Method	Online
Typical Length of Class	25 minutes
Training Cost	Free

Introduction to Data-Informed Decision Making

https://learning.qlik.com/course/view.php?id=1001

Public or Private Sector Training	Private sector
Target Audience	Business professionals
Course Content	• Understanding of data-informed decision-making • Turning data into value • Understanding of skills and competencies required to properly leverage data
Course Description	*From the web site*: This module will introduce you to data-informed decision-making.
Training Delivery Method	Online
Typical Length of Class	32 minutes
Training Cost	Free

National Highway Institute

Below are courses offered through the National Highway Institute of the Federal Highway Administration.

Safety Data and Analysis Fundamentals Training

https://www.nhi.fhwa.dot.gov/course-search?tab=0&sf=0&course_no=380122B

National Highway Institute's Safety Data and Analysis Fundamentals course offers individual learning tracks for data analysts, data collectors, project/program managers and safety advocates. Information about each of these learning tracks is provided below following the general course description and outcomes.

Course Description

From the web site: This web-based training provides the knowledge necessary to identify weaknesses in current practices and strengthen the way safety data is used in transportation programs, projects, and communities. Course participants learn about key safety data types and terms, as well as sources and collection methods. Participants study the data analysis process and several methods of data analysis, and also explore and interpret various examples throughout the training. They leave the training with the skills and knowledge necessary to evaluate data and to enhance data collection and storage methods, with awareness of the potential, as well as the limitations of these methods.

Outcomes

- Use data to support decision-making with respect to identifying safety issues, selecting countermeasures to mitigate safety issues, and evaluating the success of those countermeasures.
- Identify basic terms and concepts related to safety data and analysis, enabling participants to communicate effectively on safety-related data projects.
- Identify types, sources, strengths and weaknesses of transportation safety data.
- Explain various methods used to analyze safety data, including their application and limitations.

Data Analysts

https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Safety+Data+and+Analysis+Fundamentals+for+Data+Analysts&res=1

Public or Private Sector Training	Public sector
Target Audience	Professionals in charge of integrating and analyzing data sets, including highway safety engineers, specialists, traffic engineers, highway designers and technical analysts.
Course Description	*From the web site*: Emphasizes the applicability, uses, strengths, limitations and requirements of safety data and collection methods. Recommended for anyone whose responsibility is to analyze safety data to identify causes and potential patterns that contribute to crashes and other systemic safety issues.
Training Delivery Method	Online
Total Overall Program Hours	7 hours
Training Cost	Free
Program Assessment/References	0.7 continuing education units (CEUs)

Data Collectors/Stewards
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Safety+Data+and+Analysis+Fundamentals+Training+for+Data+Collectors%2FStewards&res=1

Public or Private Sector Training	Public sector
Target Audience	Professionals who are responsible for collecting, coding and managing data to support safety analysis and decision-making.
Course Description	*From the web site*: Emphasizes ways data collectors meet the needs of data analysts and helps collectors understand how managers use data to make strategic, informed decisions about safety priorities. Recommended for law enforcement officers, emergency medical service providers, trauma registrars, driver and vehicle service clerks, roadway data collectors, and anyone responsible for collecting crash, traffic, roadway, behavioral, injury or other safety data.
Training Delivery Method	Online
Typical Number of Hours Per Class	4 hours
Training Cost	Free
Program Assessment/References	0.4 CEUs

Project and Program Managers
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Safety+Data+and+Analysis+Fundamentals+for+Project+and+Program+Managers&res=1

Public or Private Sector Training	Public sector
Target Audience	Professionals responsible for using safety analytics to identify and prioritize safety issues, develop and implement safety countermeasures, and evaluate project/program effectiveness.
Course Description	*From the web site*: Emphasis on the trade-offs of project alternatives in terms of cost and benefits, including the safety impacts of the project/program as well as the individual components. Recommended for transportation planners, traffic records coordinating committee members, highway safety online directors, and state and local mid-level managers such as division and district program managers in highway safety, design, traffic engineering, enforcement and public health.
Training Delivery Method	Online
Total Overall Program Hours	5 hours
Training Cost	Free
Program Assessment/References	0.5 CEUs

Senior Managers and Safety Advocates
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Safety+Data+and+Analysis+Fundamentals+for+Senior+Managers+and+Safety+Advocates&res=1

Public or Private Sector Training	Public sector
Target Audience	For anyone looking to bridge the gap between the public and practitioners, and who [is] responsible for developing or influencing policies, practices, setting budgets, allocating resources, and making safety investments.
Course Description	*From the web site:* Emphasis on understanding the needs of data collectors, data managers and data analysts in terms of equipment, human resources, and organizational structure. Recommended for state and local senior managers, such as division heads/chief of transportation, planning, civil engineering and public health.
Training Delivery Method	Online
Total Overall Program Hours	5 hours
Training Cost	Free
Program Assessment/References	0.5 CEUs

Data Archiving and Analytics for Planning, Operations and Safety
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Data+Archiving+and+Analytics+for+Planning%2C+Operations%2C+and+Safety&res=1

Public or Private Sector Training	Public sector
Target Audience	Course is listed in the Intelligent Transportation Systems program area.
Course Content	• Communicate the business cases for archiving data • Understand the importance of visual analytics in making your archive more valuable • Identify real-world use cases for leveraging archives for better decision-making • Evaluate the pros and cons of different archive implementation strategies
Course Description	*From the web site*: This course is designed to help you understand the benefits of creating an open and accessible data archive of your agency's data. It will also explain the challenges you might face in trying to make your agency's data more open and available to others, and ways in which you can mitigate those challenges. After showing you some real-world examples of how data can be leveraged for better decision making and analysis, we will discuss the pros and cons of building your very own archive, leveraging technologies that others have developed, or paying a consultant to help you with your archiving needs.
Training Delivery Method	Online
Typical Length of Class	4 hours

Training Cost	Free
Program Assessment/References	0.4 CEUs

The Role of Data in Transportation Performance Management
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=The+Role+of+Data+in+Transportation+Performance+Management+&res=1

Public or Private Sector Training	Public sector
Target Audience	• Staff at FHWA, state DOTs, MPOs and national organizations, such as Association of Metropolitan Planning Organizations (AMPO) and AASHTO who would benefit from an overview of data management in the context of transportation performance management (TPM) applications and an appreciation for some basic data management concepts. • Appropriate for midlevel managers with TPM-related responsibilities; pavement, bridge, safety, road inventory, traffic data managers and analysts; IT employees who build reports or develop applications that support TPM business needs; senior agency managers with a strong interest in improving data at their organizations; entry-level data managers and analysts who support agency TPM practices. • *Note*: An overview course; does not cover technical skill development in database design, query methods, data integration or data analysis. Not intended for seasoned transportation data professionals or those seeking an in-depth coverage of data needs and uses within any single performance area.
Course Content	• Purpose and benefits of accurate and current relevant data in TPM activities • TPM data analysis needs for system performance areas • Elements of TPM and related business practices and the data that supports them • Data requirements related to use of performance projections for target setting • Common data quality issues and techniques for addressing them • Existing gaps in data quality, availability, linkage and analysis tools that impact the ability to meet federally legislated requirements, as well as support broader agency performance management processes • Data management and improvement plan development
Course Description	*From the web site*: [The goal of this course] is to enable participants to manage, analyze, integrate and use data from diverse sources to support an effective agency TPM function. … The course begins with an overview of data management. It then details each part of the data supply chain, covering common needs, considerations and challenges along the way. The course also covers issues related to data assessment and data improvement planning. The course material is synthesized at the end of the course through a group exercise in which participants create a data management and improvement plan.

Training Delivery Method	Instructor-led training; registration required
Typical Length of Class	2 days
Total Overall Program Hours	12 hours
Training Cost	$200 per person
Program Assessment/References	1.2 CEUs (course includes a written assessment)

Introduction to Highway Performance Monitoring System (HPMS)
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Introduction+to+Highway+Performance+Monitoring+System+(HPMS)+&res=1

Public or Private Sector Training	Public sector
Target Audience	State DOT HPMS coordinators and staff who collaborate within their respective agencies for HPMS purposes; HPMS program managers and leadership; performance analysts, including traffic engineers, pavement engineers, GIS analysts and roadway inventory management analysts; junior-level state DOT employees or employees unfamiliar with HPMS; and state DOT consultants.
Course Content	• Purpose of the HPMS program • Data sets that state DOTs are responsible for in the HPMS data model • Importance of submitting data according to requirements • Use of data after it is submitted • Key dates for submittal and data set lockdown • General reporting requirements • HPMS workflow • Post-submittal process requirements
Course Description	*From the web site*: The goal of this course is to introduce learners to the HPMS program, its purpose and uses, and how HPMS relates to their jobs. It will help learners understand the history of HPMS, the HPMS data model, data that must be collected and reported, and submission requirements.
Training Delivery Method	Online
Typical Length of Class	1 hour
Training Cost	Free
Program Assessment/References	0 CEUs

Making the Connection Between HPMS Data Items and TPM
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Making+the+Connection+between+Highway+Performance+Monitoring+System+(HPMS)+Data+Items+and+TPM+&res=1

Public or Private Sector Training	Public sector
Target Audience	State DOT HPMS coordinators and staff who collaborate within their respective agencies for HPMS purposes; HPMS program managers and leadership; performance analysts, including traffic engineers, pavement engineers, GIS analysts and roadway inventory management analysts; junior-level state DOT employees or employees unfamiliar with HPMS; and state DOT consultants.
Course Content	• Purpose of TPM requirements • Use of HPMS to support TPM national goals and performance measures • Importance of following data submission requirements • Reporting requirements for the Sections data set, select inventory data items, pavement data items, special networks and National Highway System data items, and travel time data items • Importance of updating existing workflows to align with reporting requirements related to TPM • Processing data to meet HPMS reporting requirements • Changes to the HPMS timeline for data collection and reporting due to TPM • Use of data post-submission
Course Description	*From the web site*: The goal of this course is to introduce you to HPMS as it relates to TPM, as well as data items used to meet TPM requirements.
Training Delivery Method	Online
Typical Length of Class	1.5 hours
Training Cost	Free
Program Assessment/References	1.5 CEUs

Highway Performance Monitoring System (HPMS): Concept, Data Collection and Reporting Requirement
https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=Highway+Performance+Monitoring+System+(HPMS)%3A+Concepts%2C+Data+Collection+%26+Reporting+Requirements+&res=1

Public or Private Sector Training	Public sector
Target Audience	State DOT HPMS staff
Course Content	• Scope and background of HPMS • HPMS data model, including the catalogs and data sets that comprise the model • Data sets developed/submitted by state DOTs and those developed/maintained by FHWA • Use of geo-referencing in HPMS for analysis and reporting

	• Structure of the Sections and Sample Panel Identification data sets • Relationship between the Sections and Sample Panel Identification data sets and their use for sampling • Data collection, coding and reporting requirements of the Sections data set • HPMS sampling framework • Use of annual average daily traffic (AADT) volume groups and precision levels in HPMS • Sample size estimation procedure and its use in HPMS • Sample adequacy and sample maintenance in HPMS • Annual submittal of various HPMS data sets
Course Description	*From the web site*: [This course] is intended to provide advanced, in-depth hands-on understanding of data collection and reporting requirements for HPMS. The workshop is designed to cover: • HPMS program background • HPMS 2010+ data model • HPMS data collection and reporting requirements • Statistical sampling requirements • HPMS submittal process
Training Delivery Method	Instructor-led training
Typical Length of Class	2 days
Training Cost	$115 per person

Professional Education Organizations

Below are data-related courses available from:

- Coursera Inc.
- Cprime Learning.
- edX Inc.
- Kubicle.
- LinkedIn Learning.
- Pragmatic Institute.
- Rutgers University.
- University of California, Davis.

Coursera Inc.

Data Management and Visualization
https://www.coursera.org/learn/data-visualization
Note: Course offered by Wesleyan University

Public or Private Sector Training	Private sector
Target Audience	Business and research professionals
Course Content	• SAS language • Data analysis • Python programming • Data management
Course Description	*From the web site:* Based on existing data, you will learn to develop a research question, describe the variables and their relationships, calculate basic statistics and present your results clearly. By the end of the course, you will be able to use powerful data analysis tools—either SAS or Python—to manage and visualize your data, including how to deal with missing data, variable groups and graphs.

Training Delivery Method	Online
Typical Length of Class	Approximately 12 hours
Total Number of Courses Offered	Five in the Data Analysis and Interpretation specialization (https://www.coursera.org/specializations/data-analysis). Other courses: • Data Analysis Tools • Regression Modeling in Practice • Machine Learning for Data Analysis • Data Analysis and Interpretation Capstone
Training Cost	• Free to audit course; fee to access graded assignments and earn a certificate • Enterprise pricing available
Program Assessment/References	Certificate available for purchase upon completion of course

Related Resource:

Coursera for Business, Coursera Inc., undated.
https://www.coursera.org/business/
From the web site: Coursera provides universal access to the world's best education, partnering with top universities and organizations to offer courses online.

Cprime Learning (Formerly American Society of Professional Education)

Data Literacy for Business Professionals
https://www.cprime.com/learning/courses/data-literacy-for-business-professionals-elearning/

Public or Private Sector Training	Private sector
Target Audience	Business professionals
Course Content	• Review key terms and concepts related to data analysis for business • Identify the roles and responsibilities of individuals involved in data • Understand how to create a data-driven culture • See the value of using data visualization tools • Develop strategies that incorporate emerging data tools and technologies
Course Description	*From the web site*: Data literacy involves understanding what data means, including how to read graphs and charts correctly, draw accurate conclusions from data, and recognize when data is being used in misleading or inappropriate ways. This basically means those who are data literate can work with and understand data. This 3-hour eLearning will teach business professionals who are lacking foundational data knowledge the terms and concepts they need to know so that they can thrive in today's digital landscape.
Training Delivery Method	Live online or self-paced
Typical Length of Class	3 hours
Total Number of Courses Offered	14 courses*
Training Cost	$195 per student

* Cprime Learning recently acquired American Society of Professional Education. Course offerings are expected to change.

Related Resource:

Cprime Learning, undated.
https://thedataliteracyproject.org/learn
From the web site: An Alten Company, Cprime is a global consulting firm helping transforming businesses get in sync. Cprime is the partner of choice for Fortune 100 companies looking to achieve value and agility. We help visionary business leaders compose solutions, execute implementations, and exceed against business goals.

edX Inc.

Data Literacy Foundations
https://www.edx.org/course/data-literacy-foundations

Public or Private Sector Training	Private sector
Target Audience	Anyone
Course Content	• Examples of how people use data every day • Legal and ethical issues associated with data • Critical thinking skills for working with data • Data analysis tools and techniques
Course Description	*From the web site*: [L]earn how critical thinking is an essential data literacy skill in today's data-driven world. … [C]onsider how you use data every day, discuss the value of data and examine the transformation of data from analog to digital forms. … [D]iscuss and use case studies to understand the ethics of data usage, as well as the key role critical thinking plays in data analysis, which ultimately drives strategic planning and informs corporate competitive advantage. All of this will culminate in the exploration of data analysis tools and methodologies.
Training Delivery Method	Self-paced online
Typical Length of Class	24-32 hours (6-8 hours per week for 4 weeks)
Training Cost	Free
Program Assessment/References	Certificate available for $249

Essentials of Data Literacy
https://www.edx.org/course/essentials-of-data-literacy

Public or Private Sector Training	Private sector
Target Audience	Anyone
Course Content	• Six steps of the data life cycle and how to apply them in R • Analyzing, managing and communicating data • Becoming a critical consumer and producer of data visualizations
Course Description	*From the web site*: Learn how to read, work with and analyze data. [This course will] take you through the six steps of the data life cycle, using different case studies and contexts, and teach you how to analyze, manage and communicate data working in R to achieve basic R programming competencies.
Training Delivery Method	Instructor-led training
Typical Length of Class	40-80 hours (10-20 hours per week for 4 weeks)

Total Number of Courses Offered	Approximately 10 courses related to data literacy
Total Overall Program Hours	Varies by program
Training Cost	Free
Program Assessment/References	Certificate available for $99

Kubicle

Data Literacy: Understanding Data
https://kubicle.com/library/data-literacy

Public or Private Sector Training	Private sector
Target Audience	Business professionals
Course Content	• Introduction to Data and Databases • Thinking and Communicating with Data • Planning a Data Driven Project
Course Description	*From the web site*: These courses teach you all the non-technical principles of understanding and working with data in your company.
Training Delivery Method	Online
Typical Length of Class	36-55 minutes
Total Number of Courses Offered	3
Total Overall Program Hours	2.25 hours
Training Cost	Pricing and plans for enterprises beginning at 10 employees to 2,000 employees
Program Assessment/References	Continuing professional development (CPD) certification available

Related Resource:

Kubicle, undated.
https://kubicle.com
From the web site:

> Kubicle enables organizations and individual to transform their data literacy skills, helping them adapt to a rapidly changing world.

LinkedIn Learning

Business Analysis and Strategy, LinkedIn Learning, undated.
https://www.linkedin.com/learning/topics/business-analysis-and-strategy?trk=learning-serp_browsemap_subject-link&upsellOrderOrigin=homepage-learning_learning-search-bar_search-submit
Topics in the Business Analysis and Strategy program include data analysis, data visualization and business intelligence. *From the web site*:

> Increase your business impact by developing skills in strategic decision-making, business analysis and critical thinking. Learn how to leverage data to make better business decisions through core concepts like data analysis and storytelling with data.

Sample courses in this program:

Data Science Foundations: Fundamentals
https://www.linkedin.com/learning/data-science-foundations-fundamentals-6?trk=learning-topics_learning_search-card&upsellOrderOrigin=homepage-learning_learning-search-bar_search-submit

Public or Private Sector Training	Public and private sectors
Target Audience	Business professionals
Course Content	• Sources of Data and Rules • Tools for Data Science • Data Science Analysis
Course Description	This course provides a nontechnical overview of data science to help professionals make better decisions, gain deeper insights, and make work more effective and efficient. Topics include the vocabulary, skills, jobs, tools and techniques of data science; relationships to other data-saturated fields such as machine learning and artificial intelligence; primary practices such as gathering and analyzing data, formulating rules for classification and decision-making, and drawing actionable insights; and ethics and accountability.
Training Delivery Method	Online
Typical Length of Class	3 hours, 41 minutes
Training Cost	Pricing and plans available for government teams

Data Visualization, Storytelling and Information Design: A Lesson and Listen Series
https://www.linkedin.com/learning/data-visualization-a-lesson-and-listen-series/lesson-data-literacy?trk=learning-serp_learning_search-card&upsellOrderOrigin=homepage-learning_learning-search-bar_search-submit

Public or Private Sector Training	Public and private sectors
Target Audience	Business professionals
Course Content	• Data Literacy • Data Storytelling and Visualization • Visualizing Large Data Sets • Data Visualization Research
Course Description	This ongoing series explores key themes in data visualization, data storytelling and information design. Conversations with experts examine “the creative process, explore techniques and technologies used by working professionals, and illuminate some of the common challenges they face. This series is perfect for anyone interested in how information is presented to the mass market, including professionals in all levels of analytics, data science and communications.”
Training Delivery Method	Online
Typical Length of Class	Varies
Total Number of Courses Offered	17

Total Overall Program Hours	7 hours, 11 minutes
Training Cost	Pricing and plans for government teams

Learning Data Analytics
https://www.linkedin.com/learning/learning-data-analytics-2?trk=learning-topics_trending-courses_related-content-card&upsellOrderOrigin=homepage-learning_learning-search-bar_search-submit

Public or Private Sector Training	Public and private sectors
Target Audience	Business professionals
Course Content	• Getting Started With Data Analysis • Fundamentals of Data Thinking • Key Elements of Data Analysis • Working With Business Data
Course Description	Analysts and nonanalysts learn the basics of data analytics and reporting. The course defines what data analytics is and what data analysts do; how to identify your data set—including the data you don't have—and interpret and summarize data; how to perform specialized tasks such as creating workflow diagrams, cleaning data and joining data sets for reporting; best practices for data analytics projects; and techniques for repurposing, charting and pivoting data.
Training Delivery Method	Online
Typical Length of Class	1 hour, 39 minutes
Training Cost	Pricing and plans available for government teams
Program Assessment/References	Certificate of completion available

Related Resource:

Solutions for Government, LinkedIn Learning, undated.
https://learning.linkedin.com/for-governments?src=li-learning-nav&trk=learning-topics_enterprise-nav&upsellOrderOrigin=homepage-learning_learning-search-bar_search-submit
From the web site:

> Meet the needs of government workers: Employees today expect learning technology to be collaborative, self-directed, and easy to use. This is especially true of [m]illennial and Gen Z professionals, who will soon make up the majority of the workforce. LinkedIn Learning meets the needs of professionals today with personalized, data-driven course recommendations and seamless desktop and mobile experiences.

Pragmatic Institute

Data Training for Tomorrow, Pragmatic Institute, undated.
https://www.pragmaticinstitute.com/data-science/
Access to data science courses and a data resource library is available at this site.

Rutgers University

Data Literacy: Courses and Workshops, Rutgers University, 2020.
https://libguides.rutgers.edu/data_literacy/online_courses
This web page provides a list of available online courses, training workshops and tutorials related to data, data literacy and data management.

University of California, Davis

Data Analytics Boot Camp
https://bootcamp.ucdavis.edu/data/

Public or Private Sector Training	Private sector
Target Audience	Business professionals
Course Content	• Intermediate Excel (pivot tables, Visual Basic for Applications scripting) • Fundamental statistics (modeling, forecasting). • Python programming (Python 3, NumPy, Pandas, Matplotlib, API interactions) • Databases (MySQL, MongoDB, ETL) • Front-end web visualization (HTML, CSS, Bootstrap, dashboarding, JavaScript charting, D3.js, geomapping with Leaflet.js) • Business intelligence (Tableau) • Advanced topics (big data analytics with Hadoop, machine learning)
Course Description	*From the web site*: The UC Davis Data Analytics Boot Camp puts the student experience first, teaching you the knowledge and skills to conduct analytics on a wide array of real-world problems. In just 24 weeks, you'll journey through a challenging curriculum and gain the specialized skills needed to analyze big data and turn it into clear insights.
Training Delivery Method	Online
Typical Length of Program	24 weeks
Total Number of Courses Offered	6 modules
Total Overall Program Hours	336 hours (14 hours per week)
Training Cost	Not available

Related Resource:

UC Davis Boot Camps, University of California, Davis, undated.
https://bootcamp.ucdavis.edu/
From the web site:

> Our programs get students ready with the in-demand skills they need to advance or start a career in coding, data analytics, cybersecurity, or digital marketing. We combine a virtual classroom experience with dynamic curricula taught by experienced instructors.

Related Research and Resources

A literature search of recent publicly available resources identified publications and online materials that are organized into the following topic areas:

- California resources.
- Other domestic research and guidance.
- International resources.
- Related resources.

California Resources

DataSF, Office of Chief Data Officer, City and County of San Francisco, undated.
https://datasf.org/
From the site description: Our mission is to empower use of the City and County of San Francisco's data. Our core product is SF OpenData, the official open data portal.

Related Resources:

Course Catalog: Data Academy, DataSF, Office of Chief Data Officer, City and County of San Francisco, undated.
https://datasf.org/academy/
[*Note*: Data Academy workshops are temporarily suspended due to COVID-19 public health protocols.]

This course catalog lists the free Data Academy tool- and skill-focused workshops only available to employees of the city and county of San Francisco with a supervisor's approval. Courses are available in the following topic areas:

- Analysis.
- Data management.
- Data visualization.
- Excel.
- Information design.
- Process improvement.
- Tableau.
- PowerBI.

Resource Library, DataSF, Office of Chief Data Officer, City and County of San Francisco, undated.
https://datasf.org/resources/
Collections of resources, including a data coordinator guidebook and a data inventory template, are available in the following topic areas:

- Data coordinator guidance.
- Data quality.
- DataSF strategic planning.
- DataScienceSF.
- Getting started with Stat and dashboarding.
- Managing personal data requests.
- Open data metrics.
- Open data operations and management.
- Open data release toolkit.
- Power BI.
- Results Based Accountability (RBA).
- Standard: Metadata.
- Standard: Open data licensing.

Data Academy Program Performance, DataSF, Office of Chief Data Officer, City and County of San Francisco, 2020.
https://datasf.org/academy/performance/
From the web site:

> Data Academy measures success in terms of the number of analysts trained, attendee satisfaction with courses, and the time saved by analysts because of the skills learned in Data Academy courses. See this attendance data, satisfaction data, and hours saved in the dashboard below.

Graphs charting attendance data, satisfaction data and hours saved illustrate the ongoing impact of program courses.

The Results are In: Data Academy Makes a Big Impact!, Blog Post, DataSF, Office of Chief Data Officer, City and County of San Francisco, undated.
https://datasf.org/blog/the-results-are-in-data-academy-makes-a-big-impact/
This post summarizes the Data Academy's use of a data-driven approach to measure the program's impact. Infographics illustrate skill improvement, frequency of program use, time and money saved, skills application and other program benefits. Based on an estimate of 700 attendees, the program saved the city more than $1.7 million in fiscal year 2017.

"San Francisco's Data Academy Develops a Data-Savvy Workforce," Blake Valenta, *Data-Smart City Solutions*, Ash Center for Democratic Governance and Innovation, Harvard Kennedy School, February 2017.
https://datasmart.ash.harvard.edu/news/article/san-franciscos-data-academy-develops-a-data-savvy-workforce-973
The genesis and development of DataSF and Data Academy are described. *From the article*:

> The hunger for training found in San Francisco's employees is present in any city whose challenges and solutions rely on the successful interrogation and presentation of data. Data Academy is a leading example of how a city can tackle this challenge with internal resources. "Part of the mission of the City Performance Unit is to help city departments make more of their decisions with information and data, and Data Academy has greatly accelerated this process," said [Peg Stevenson, director of the City Performance Unit, San Francisco Office of the Controller]. This starts with enabling individual analysts to think about data in new ways and fostering these capacities and broader culture change through collaboration and networking. By training analysts in the tools and concepts they need to effectively employ data in their work, Data Academy empowers a data-driven future for the City and County of San Francisco.

Other Domestic Research and Guidance

"Boost Your Team's Data Literacy," Josh Bersin and Marc Zao-Sanders, *Harvard Business Review*, February 12, 2020.
https://hbr.org/2020/02/boost-your-teams-data-literacy
From the article:

> Schools and colleges are often ill-equipped to solve the problem of data literacy. Math curricula prioritize critical core concepts (calculus and algebra) above more applied subjects

like statistics and probability. Campaigns for greater pragmatism—like this 20-year-old paper [cited below]—have gone largely unheeded.

Today, the responsibility has shifted from academic institutions to employers, where skills development programs are flourishing. Companies like Bloomberg, Guardian Insurance, and Adobe now have data science and digital academies that are focused on helping employees in all disciplines learn how to analyze data.

This is a responsibility more employers should embrace. They have the resources, and they'd certainly reap the rewards.

The authors conducted a focus group of 20 companies that reported their analytics teams "were not suffering from a lack of technical skills, but from skills in data-driven problem solving." They recommend "practical solutions to boost data capabilities":

- Make sure people know how to use software tools.
- Establish a "capability academy" for data skills—a place supported by the company's business leaders to help employees advance specific job-related skills.
- Use examples and stories in awareness campaigns to teach and inspire others about how to use data well.
- Include data in all important decision-making.

Related Resource:

"Numeracy: The New Literacy for a Data-Drenched Society," Lynn Arthur Steen, *Educational Leadership*, Vol. 57, No. 2, pages 8-13, October 1999.
http://www.ascd.org/publications/educational_leadership/oct99/vol57/num02/Numeracy@_The_New_Literacy_for_a_Data-Drenched_Society.aspx
From the abstract: After presenting a brief history of numeracy in the United States—from the founding fathers to the NCTM [National Council of Teachers of Mathematics] standards, the author describes a numeracy-enhancing curriculum, which crosses disciplines, presents numbers in many situations, is broader than the traditional pre-algebra-calculus sequence, and asks students to apply numeracy in real-world contexts.

"5 Strategies for Building a Culture of Data Literacy," Andrew Churchill, Nextgov.com, November 26, 2019.
https://www.nextgov.com/ideas/2019/11/5-strategies-building-culture-data-literacy/161508/
From the article: Getting agency buy-in to a culture of data literacy means getting everyone at every level to appreciate the value of data for their daily operations and their agency's mission. It's building trust in data tools and their results, and increasing the comfort people have using those tools and data in general. Without that trust and comfort, investing in data tools and technology is a waste of time, money and effort. Agencies looking to increase their data literacy should explore these five proven strategies:

- Build a community and recruit champions.
- Use tailored language and examples.
- Listen to your people and data.
- Quantify the mission impact.
- Encourage experimental projects.

10 Ways CDOs Can Succeed in Forging a Data-Driven Organization, Mike Rollings, Alan D. Duncan and Valeris Logan, Gartner.com, May 22, 2019.
https://www.gartner.com/doc/reprints?id=1-1ZM4VXMV&ct=200804&st=sb
Ten best practices are described in detail to help senior leaders transform companies into data-driven organizations:

- Define the vision, priorities and scope of your chief data officer (CDO) role.
- Forge a partnership with your chief information officer.
- Build a data-driven enterprise, not a department.
- Prioritize cultural change and foster a data-driven orientation.
- Focus your organization on treating information as a business asset.
- Expand your information monetization options.
- Measure information so you can value it.
- Adapt information innovation ideas from others.
- Leverage alternative external data sources.
- Deal with risk by facing information ethics head-on.

From the article overview:

Key Challenges:

- Data and analytics leaders may not recognize that the definition of data and analytics success is to become an enterprise engine of value creation.
- Culture and data literacy are the top two roadblocks for data and analytics leaders.
- "Information as an asset" is a popular idea, but a scarcity of asset management standards, unfamiliarity with data monetization and a lack of experience prevents data and analytics leaders from driving value from data.

Recommendations:
To achieve success in their role, data and analytics leaders, including CDOs, must:

- Establish clarity for the CDO's role and purpose by defining and advocating the role's vision, priorities and scope.
- Transform their enterprise by prioritizing cultural change and fostering a data-driven orientation.
- Apply asset management disciplines to select information assets and borrow ideas from other industries and competitors to monetize their data.
- Apply all of these 10 best practices to aid the data-driven transformation of their enterprise.

"Repositioning Data Literacy as a Mission-Critical Competence," Sheila Corrall, *Proceedings of the Association of College & Research Libraries 2019 Conference*, April 2019.
http://d-scholarship.pitt.edu/36975/
From the abstract: With data rapidly replacing information as the currency of research, business, government, and health care, is it time for librarians to make data literacy central to their professional mission, take on roles as interdisciplinary mediators, and lead the data literacy movement on campus? Join the data literacy debate and discuss what librarians can do to cut across the disciplinary and professional silos now threatening the development of lifewide data literacy. Investigate and critique diverse conceptions and pedagogies for data literacy, and

experiment with the MAW [Mitchell, Agle and Wood] theory of stakeholder saliency to identify individuals and groups to target in your data literacy initiatives.

"Champion Data Literacy and Teach Data as a Second Language to Enable Data-Driven Business," Kasey Panetta, Smarter With Gartner, February 6, 2019.
https://www.gartner.com/smarterwithgartner/a-data-and-analytics-leaders-guide-to-data-literacy/
This article explains why data literacy is important and highlights initial steps for creating a data-driven organization.

"Data Science for All: A University-Wide Course in Data Literacy," David Schuff, A*nalytics and Data Science,* pages 281-297*,* October 7, 2017.
https://link.springer.com/chapter/10.1007/978-3-319-58097-5_20
From the abstract: Infusing data literacy into a curriculum is an unrealized opportunity for higher education to truly make an impact on the current generation as they prepare to move into the workforce. This chapter describes the design and structure of a new, unique undergraduate elective course introduced into the curriculum of a large, public [u]niversity in the [n]ortheastern United States. The design of the course is designed to inspire an "evidence-based" mindset, encouraging students to identify and use data relevant to them in their field of study and the larger world around them. The chapter includes the course goals mapped to specific learning objectives, examples of exercises and assignments, a reading list, and a course syllabus. Instructors and institutions interested in bringing data science concepts to a broad audience can use this course as a foundation to build their own curriculum in this area.

"Data Information Literacy Instruction in Business and Public Health: Comparative Case Studies," Katharine V. Macy and Heather L. Coates, *IFLA [International Federation of Library Associations and Institutions] Journal*, Vol. 41, Issue 4, pages 313-327, December 2016.
https://journals.sagepub.com/doi/abs/10.1177/0340035216673382
From the 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 master 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.

"Graph Literacy and Business Intelligence: Investigating User Understanding of Dashboard Data Visualizations," S. Wakeling, P. Clough, J. Wyper and A. Balmain, *Business Intelligence Journal*, Vol. 20, Issue 4, pages 8-19, December 7, 2015.
https://researchoutput.csu.edu.au/en/publications/graph-literacy-and-business-intelligence-investigating-user-under
From the abstract: It is now commonly accepted that data visualizations offer a valuable means of communicating business intelligence to users. However, although much time and effort has been expended on developing rich dashboard interfaces and understanding the optimum design of different visualization types, less attention has been paid to graph literacy-—whether dashboard users can effectively understand these visualizations. We describe the results of a gamified study investigating user graph literacy in a range of comprehension levels for a variety of common dashboard data visualizations. Our results show that participants were more successful in understanding some visualizations [more] than others. Those visualizations with

which participants were least familiar tended to elicit the fewest correct answers. More surprising is the relatively poor performance of participants in answering questions relating to data presented in tabular form. We also observe that users remain confident in their ability to understand familiar visualizations even when their actual performance is poor. Perceived performance is more closely related to actual performance when familiarity is low. In both cases, vendors and managers should be aware of these effects and appropriately support the implementation of new visualizations while considering methods of ensuring accurate use of familiar ones.

Federal Data Strategy: Leveraging Data as a Strategic Asset, U.S. Department of Commerce, Small Business Administration, Office of Management and Budget, and Office of Science and Technology Policy, undated.
https://strategy.data.gov/
From the web site:

> To meet the changing role of data and needs of democracy, the [f]ederal [g]overnment created a coordinated and integrated data strategy that better enables data to deliver on mission, serve the public and steward resources while respecting privacy and confidentiality.
>
> The mission of the Federal Data Strategy is to fully leverage the value of federal data for mission, service and the public good by guiding the [f]ederal [g]overnment in practicing ethical governance, conscious design and a learning culture.

The site elaborates on multiple practices and action steps in three areas:

- Building a culture that values and promotes public use.
- Governing, managing and protecting data.
- Promoting efficient and appropriate data use.

International Resources

Digital Academy, Government of Canada, 2020.
https://www.csps-efpc.gc.ca/digital-academy/index-eng.aspx
From the web site:

> The CSPS Digital Academy was established by the Canada School of Public Service (CSPS) in 2018 to help federal public servants gain the knowledge, skills and mindsets they need in the digital age. It supports the principles of Canada's Beyond2020 initiative for an agile, inclusive and equipped workforce and advocates for a digital-first approach that aligns with Canada's Digital Standards. These 10 digital standards form the foundation of the government's shift to becoming more agile, open and user-focused.

The academy offers classroom and online courses in six areas, including Discover Data, "[a] series designed to develop data competencies in support of a data‑literate workforce," which aims to:

- Develop data competencies in support of a data-literate workforce.
- Create a common language around data.
- Create a community of like-minded individuals who can support each other's learning and experimentation.

"Novel Approaches for a Scalable and Effective Data Literacy Program," Sushant Ajmani, Course5 Intelligence, June 2020.
https://www.course5i.com/blogs/scalable-and-effective-data-literacy-program/
This online article discusses six approaches that organizations can take to make their data literacy programs successful:

- Create a group of infinite and explicit learners.
- Create a culture of experimentation.
- Decentralize your analytics function.
- Set up a closed-feedback loop and productize your process and operations knowledge.
- Augment your data stories for better adoption.
- Develop product mindset when it comes to data and its consumption.

Data Literacy: What It Is and How to Measure It in the Public Service, Aneta Bonikowska, Claudia Sanmartin and Marc Frenette, Statistics Canada, August 2019.
https://www150.statcan.gc.ca/n1/en/pub/11-633-x/11-633-x2019003-eng.pdf?st=nisqJ8-Y
From the abstract: This report provides an overview of the definitions and competency frameworks of data literacy, as well as the assessment tools used to measure it. These are based on the existing literature and current practices around the world. Data literacy, or the ability to derive meaningful information from data, is a relatively new concept. However, it is gaining increasing recognition as a vital skill set in the information age. Existing approaches to measuring data literacy—from self-assessment tools to objective measures, and from individual to organizational assessments—are discussed in this report to inform the development of an assessment tool for data literacy in the Canadian public service.

"Data Literacy: What It Is and How Can We Make It Happen?" Mark Frank, Johanna Walker, Judie Attard and Alan Tygel, *Journal of Community Informatics*, Vol. 12, No. 3, November 28, 2016.
http://blog.ci-journal.net/index.php/ciej/article/view/1347
Access to the entire journal: http://blog.ci-journal.net/index.php/ciej/issue/view/59
This entire special issue addresses data literacy and includes case studies, notes from the field and commentary on data literacy challenges. *From the abstract:* With the advent of the [i]nternet and particularly [o]pen [d]ata, data literacy (the ability of non-specialists to make use of data) is rapidly becoming an essential life skill comparable to other types of literacy. However, it is still poorly defined and there is much to learn about how best to increase data literacy both amongst children and adults. This issue addresses both the definition of data literacy and current efforts on increasing and sustaining it. A feature of the issue is the range of contributors. While there are important contributions from the UK, Canada and other Western countries, these are complemented by several papers from the Global South where there is an emphasis on grounding data literacy in context and relating it [to] the issues and concerns of communities.

Strategies and Best Practices for Data Literacy Education: Knowledge Synthesis Report, Chantel Ridsdale, James Rothwell, Mike Smit, Hossam Ali-Hassan, Michael Bliemel, Dean Irvine, Daniel Kelley, Stan Matwin and Brad Wuetherick, Dalhousie University, 2015.
https://dalspace.library.dal.ca/bitstream/handle/10222/64578/Strategies%20and%20Best%20Practices%20for%20Data%20Literacy%20Education.pdf
From the executive summary:

> We begin by establishing the skills that comprise data literacy. Data literacy is the ability to collect, manage, evaluate and apply data in a critical manner. We define the core skills and

competencies that comprise data literacy, using a thematic analysis of the elements of data literacy described in peer reviewed literature. These competencies (23 in total) and their skills, knowledge and expected tasks (64 in total) are organized under the top level elements of the definition (data, collect, manage, evaluate, apply) and are categorized as conceptual competencies, core competencies and advanced competencies. This view of data literacy is central to our synthesis, which includes two primary sections: the context and strategic value of data literacy education, and best practices for teaching data literacy across disciplines. There also remains much we do not know, and further steps that need to be taken, to understand data literacy instructions.

Four appendices offer a significant level of detail:

- Appendix 1: Data Literacy Competencies Matrix (page 38 of the report and PDF).
- Appendix 2: Data Literacy Definitions Word Cloud (page 42 of the report and PDF).
- Appendix 3: Key Themes in Data Literacy Literature (page 43 of the report and PDF).
- Appendix 4: Annotated Bibliography (page 48 of the PDF).

"Research Data Literacy," René Schneider, *Communications in Computer and Information Science*, Vol. 397, pages 134-140, 2013.
Citation at https://link.springer.com/chapter/10.1007/978-3-319-03919-0_16
From the abstract: This paper describes a pragmatic approach for the mediation and the teaching of research data literacy, i.e., those dimensions of information literacy that are dedicated to the creation, management and reuse of research data. Based on prior work concerning the foundations of information literacy and curricula construction for data curation, the paper will begin with the definition of research data literacy, before describing an approach based on a fusion of core skills and a two dimensional matrix that reflects on the one hand the different student populations, and on the other hand a scale of various teaching modules. This matrix might serve as the basis for an operational implementation of different study programs.

From the introduction: Due to the fact that not only the current scientists, but also the actual and forthcoming generations of students of almost all disciplines will have to work with the research data, the paper will mainly discuss the need for teaching the students in a new sub-discipline of information literacy, namely "research data literacy." As this term shows, there are strong parallels with information literacy and the first can be seen as an offspring of the latter. This parallelism will be shown in reference to prior works concerning the definition of prototype curricula before striving towards the formulation of a complementary curriculum for research data literacy.

School of Data, undated.
http://schoolofdata.org/
From the web site: School of Data is a global network committed to advancing data literacy in civil society. Information that directly impact[s] people's lives is increasingly accessible but civil society is falling behind in making effective use of it. Through our global network of data literacy practitioners and trainers, School of Data seeks to address this data skills gap in order to amplify the messages of civil society through the use of data. We level the playing field by ensuring that civil society organisations and newsrooms have the knowledge, resources and tools they need to participate fully in the information age.

Open Data Institute, undated.
https://theodi.org/events/
As this web site indicates, the Open Data Institute "was co-founded in 2012 by the inventor of the web Sir Tim Berners-Lee and artificial intelligence expert Sir Nigel Shadbolt to show the value of open data, and to advocate for the innovative use of open data to affect positive change across the globe." The Events page cited here offers information about free weekly talks and courses that provide "data literacy and capability for everyone."

Related Resources

The resources in this section address business intelligence and related topics.

Why Analytics Alone is No Longer Enough, James Fisher, TechNative, January 5, 2020.
https://www.technative.io/2020-trends-analytics-alone-is-no-longer-enough/
From the article: "Likes" in social media polarize us, where algorithms favor inflammatory content, evoke stronger reactions and keep us hooked longer. We've seen fragmentation when it comes to local laws, regulations and privacy. In the private sector, business schools, strategy heads and activist investors preach to divest anything that's not a core competency but in a fragmented world, with digital giants lurking around the corner, do we need to think different? For regulations, business models and data—which increasingly is the same thing—we can turn a fragmenting landscape into an opportunity. But analysis isn't enough. We need synthesis AND analysis to connect distributed data to the analytic supply chain—with catalogues as the connective tissue. The tech is there today but it also needs to be followed by the right processes and people. Synthesis and analysis [are] critical to make use of pervasive data and facilitate the evolution towards what we call "laying the data mosaic."

Related Resources:

> **BI & Data Trends 2021: The Great Digital Switch**, QlikTech International, undated.
> https://www.qlik.com/us/bi/data-trends
> Qlik plans to publish a free downloadable e-book that will expand on the above-cited topics.
>
> **How to Choose a Modern Analytics Platform**, Evaluation Guide, QlikTech International, undated.
> https://www.qlik.com/us/resource-library/how-to-choose-a-modern-analytics-platform
> *From the web site*:
>
> > Businesses everywhere understand a basic truth in today's economy: No enterprise can lead—or even survive—without analytics. But not all analytics platforms are created equal. Choosing the right one is essential to making discoveries that have the power to drive real change. But too often the evaluation is based on [narrowly focused] criteria around just features and functions, limiting the impact analytics can bring to your organization.
>
> This guide presents an evaluation process for choosing an appropriate analytics platform. The process is based on five key considerations:
>
> - Be specific about the ways in which analytics will drive value.
> - Identify which users really are important.
> - Go beyond total cost of ownership to recognize the costs of doing analytics wrong.

- Focus on business intelligence and analytics capabilities that deliver widespread value.
- Identify the capabilities needed to drive digital transformation.

Qlik Resource Library, QlikTech International, undated.
https://www.qlik.com/us/resource-library?page=2
Many online resources about data literacy, business intelligence and related issues are available at this site, including report guides, briefs, white papers, customer stories, webinars and videos.

What is Business Intelligence (BI)? A Collection of Definitions From Industry Experts and Answers to the Questions You May Be Asking, Klipfolio, undated.
https://www.klipfolio.com/resources/articles/what-is-business-intelligence
This web page defines business intelligence ("an umbrella term to describe concepts and methods to improve business decision making by using fact based support systems"), describes business intelligence software and explains the organizational benefits of implementing business intelligence.

NCHRP Report 936: Guide to Ensuring Access to the Publications and Data of Federally Funded Transportation Research, Carol A. Flannagan, Jared Lyle, Jacob Carlson and Denise Bedford, 2020.
Publication available at http://www.trb.org/Publications/Blurbs/180230.aspx
This report is "[c]entered on issues of data management and open data access" and is expected to "help state DOTs and other organizations that receive transportation-related federal funds to comply with recent U.S. DOT requirements for the publication and communication of scientific knowledge." Two chapters of interest:

- Chapter 7, Managing Research Data (beginning on page 53 of the report, page 64 of the PDF), which examines how to manage, access and use transportation research data.
- Chapter 8, Data Management Plans (beginning on page 67 of the report, page 78 of the PDF), which researchers use to describe the data that will be generated in a research project and how it will be made accessible.

Learn DWH: Data Warehousing, Tutorials Point, 2020.
https://www.tutorialspoint.com/dwh/index.htm
From the web site: A data warehouse is constructed by integrating data from multiple heterogeneous sources. It supports analytical reporting, structured and/or ad hoc queries and decision making. This tutorial adopts a step-by-step approach to explain all the necessary concepts of data warehousing.

Related Resources:

The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Third Edition, Ralph Kimball and Margy Ross, Wiley, 2013.
https://www.kimballgroup.com/data-warehouse-business-intelligence-resources/books/data-warehouse-dw-toolkit/
From the abstract: This new third edition is a complete library of updated dimensional modeling techniques, the most comprehensive collection ever. It covers new and enhanced star schema dimensional modeling patterns, adds two new chapters on ETL [extract, transformation and load] techniques, includes new and expanded business matrices for 12 case studies and more.

Top 15 Business Intelligence Tools: An Overview, Erin Gilliam Haije, Mopinion, Blog Post, November 6, 2019.
https://mopinion.com/business-intelligence-bi-tools-overview/
This article compares features of the top 15 business intelligence tools, including robustness, integration capabilities, technical ease of use and pricing. *From the blog post*:

> If you are considering implementing a business intelligence tool, or BI tool, there are tons of different options. Business intelligence tools are all about helping you understand trends and deriving insights from your data so that you can make tactical and strategic business decisions. But how do you know which business intelligence tool helps you achieve the online goals?
>
> In fact, many [small] businesses are hopping on the BI bandwagon, especially as the prevalence of big data continues to rise. In fact, according to BetterBuys, this market is so popular that it is predicted to grow to $20 billion by 2019.

Contacts

CTC contacted the individuals below to gather information for this investigation.

State Agencies

Florida

Joel Worrell
Manager, Transportation Data Inventory
Florida Department of Transportation
850-414-4715, joel.worrell@dot.state.fl.us

Minnesota

Angela Boardman
Information Governance Coordinator and Business Data Catalog, Information Governance
Minnesota Department of Transportation
651-296-3000,
angela.boardman@state.mn.us

Nebraska

Lou Anne Daugherty
Data Warehouse Manager, Business Technology Support Division
Nebraska Department of Transportation
402-479-4799,
louanne.daugherty@nebraska.gov

Nevada

Sherri McGee
Deputy Chief, Information Technology
Nevada Department of Transportation
775-888-7700, smcgee@dot.nv.gov

New Hampshire

Jeff Harpring
Project Manager, Executive Office
New Hampshire Department of Transportation
603-271-6299, jeff.harpring@dot.nh.gov

New York

Lynn Weiskopf
Director, Office of Policy, Planning and Performance
New York State Department of Transportation
518-457-3439, lynn.weiskopf@dot.ny.gov

Oregon

Denise Whitney Dahlke
Manager, Strategic Data Program
Oregon Department of Transportation
971-719-6274, denise.d.whitney-dahlke@odot.state.or.us

Vermont

Richard A. Scott
Data Services Manager, Asset Management Bureau
Vermont Agency of Transportation
802-505-8226, rick.scott@vermont.gov

Wisconsin

Lisa Morrison
Chief, Enterprise Data Services Section, Bureau of Information Technology Services
Wisconsin Department of Transportation
608-264-9969, lisaa.morrison@dot.wi.gov

Metropolitan Planning Organization

San Diego Association of Governments (SANDAG)

Pat Landrum
Manager, Data Solutions
619-595-5602, pat.landrum@sandag.org

Other Agencies

American Association of State Highway and Transportation Officials (AASHTO)

Penelope Weinberger
Transportation Data Program Manager,
Policy and Government Relations
American Association of State Highway and
Transportation Officials
202-624-3556, pweinberger@aashto.org

California Health and Human Services Agency

David Sanabria
Data Architect, Chief Data Strategist
Office of Systems Integration
California Health and Human Services Agency
916-263-4109, david.sanabria@osi.ca.gov

Appendix A: Survey Questions

The following survey was distributed to members of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Data Management and to representatives from a selected group of California metropolitan planning organizations.

Survey on Data Literacy Training Programs

Note: The response to the question below determined how a respondent was directed through the survey.

(Required) Has your agency implemented a data literacy training program?

Response Options:

- No, and we have no interest in implementing one. (Directs the respondent to the **Agencies Without a Data Literacy Training Program** section of the survey.)
- No, but we're considering implementing one. (Directs the respondent to the **Agencies Considering a Data Literacy Training Program** section of the survey.)
- Yes. (Directs the respondent to **Program Background** in the **Agencies With a Data Literacy Training Program** section of the survey and the sections that follow it.)

Agencies Without a Data Literacy Training Program

Please briefly describe why your agency has no interest in implementing a data literacy training program.

Note: After responding to the question above, the respondent was directed to the **Wrap-Up** section of the survey.

Agencies Considering a Data Literacy Training Program

Please briefly describe your agency's interest in implementing a data literacy training program.

Note: After responding to the question above, the respondent was directed to the **Wrap-Up** section of the survey.

Agencies With a Data Literacy Training Program

Program Background

1. Does your agency offer an enterprisewide (or agencywide) data literacy training program?
    - Yes
    - No (Please describe the more limited scope of the training program.)
2. Please briefly describe your agency's data literacy training program.
3. When did your agency implement the program?
4. Please briefly describe how your agency settled on the approach used to develop and deliver the training.

Program Details

1. Who is eligible to participate?
2. Who developed the training program content?
    - We developed all training materials in-house.
    - We purchased all training materials. (Please respond to **Question 2A**.)
    - We use a combination of in-house and purchased training materials. (Please respond to **Question 2A**.)
    - We collaborated with a consultant to develop the training materials. (Please respond to **Question 2B**.)
    - Other (Please describe.)

2A. Please provide the name of the vendor and briefly describe the scope of the training materials your agency purchased.

2B. Please provide the name of the consultant your agency engaged and briefly describe the consultant's role in developing the training materials.

3. How is the training delivered?
    - All online courses
    - All in-person courses
    - Hybrid of online and in-person courses, with greater emphasis on online learning
    - Hybrid of online and in-person courses, with greater emphasis on in-person learning
    - Other (Please describe.)
4. Who delivers the training?
    - All in-house staff
    - All consultants
    - Hybrid, with an emphasis on in-house staff
    - Hybrid, with an emphasis on consultants
    - Other (Please describe.)
5. Please describe each of the program elements below.
    - Typical number of hours per class
    - Total number of courses offered
    - Total overall program hours
    - Period of time the typical employee completes the full program
6. Does the training program include pre- and post-assessments of employee skills?
    - No
    - Yes (Please describe how and when you use these assessments.)
7. Please identify the topic areas addressed in your agency's data literacy training program. Select all that apply.
    - Data analysis
    - Data collection
    - Data ethics
    - Data interpretation
    - Data manipulation
    - Data organization and management
    - Data quality
    - Data security
    - Data sharing
    - Data storage and access
    - Data tools
    - Data visualization
    - Data-driven decision-making
    - Metadata
    - Presenting data

- Process improvement
- Reporting
- Other (Please describe.)

8. Does your agency have a certification program associated with its data literacy training program (e.g., Certified Data Analyst)?
    - No
    - Yes (Please briefly describe the certification program.)
9. Please rate your agency's maturity level for data literacy and training for each of the levels below using the rating scale of 1 = not at all mature to 5 = extremely mature.
    - *Level 1: Organizing.* Collecting data, data analysis, some data quality measures and some data training.
    - *Level 2: Data Foundation.* Data integration, data warehouse and master data management.
    - *Level 3: Basic Reporting.* Automated reporting for operational and regulatory requirements using organized foundational data (not purely ad hoc data from disparate systems).
    - *Level 4: Performance Management.* Automated enterprisewide dashboards and scorecards, business intelligence and analytics methods inform an organization's strategic and tactical business decisions.
    - *Level 5*: Predictive. Predictive analysis and advanced analytics used in decision support.
    - *Level 6: Prescriptive.* Optimize trade-offs between business goals while considering predictions/rules used in decision support.
10. Please provide links to documents associated with your agency's data literacy training program. Send any files not available online to carol.rolland@ctcandassociates.com.

Program Monitoring

1. Does your agency employ a tracking system to monitor who is trained and when?
    - No
    - Yes (Please describe the tracking system.)
2. Has your agency attempted to measure specific impacts of the training program?
    - No
    - Yes (Please describe these measurement practices and the impacts identified.)

Program Assessment and Recommendations

1. What successes has your agency experienced with its data literacy training program?
2. What challenges has your agency experienced with its data literacy training program?
3. What are your top three recommendations for other agencies developing a data literacy training program?

Wrap-Up

Please use this space to provide any comments or additional information about your previous responses.