

Competency Map for the Data Science and Analytics-Enabled Graduate

Purpose of Competency Map

The purpose of this competency map is to identify the specific skills, knowledge, abilities, and attributes required to operate effectively as a data science and analytics (DSA)-enabled graduate. This competency map establishes a framework to clarify the capabilities expected from a DSA-enabled graduate, facilitating communication between graduates, employers, educational institutions, and other DSA stakeholders.

The competency map is meant to be viewed holistically; while individual competencies are defined, many of these competencies are interdependent, within and between tiers and blocks. Therefore learning, teaching, or applying skills in DSA will bring together multiple competencies, even for the most basic matters. The interrelated nature of the competencies also meant that some individual competencies could reasonably have been placed in other blocks or tiers, further reinforcing that the map should be considered in its entirety rather than piecemeal.

The information in this competency map is meant to be used broadly by the DSA stakeholder community. For employers, this map might help to define position descriptions, establish a framework evaluating new hires, or outline paths for additional training in DSA skills. For students, the map outlines the competencies they should seek to build their DSA skills. For educators, this map offers a set of learning outcomes to guide students' progress in DSA; the map framework offers faculty members the flexibility to develop competencies within a single course or throughout a series of courses.

Competency Map Framework

The DSA-Enabled Graduate Competency Map is depicted in a pyramid graphic with four tiers. This shape illustrates how industry competencies are built on a foundation of personal effectiveness, academic, and workplace competencies. Each tier is comprised of blocks representing the skills, knowledge, and abilities essential for successful performance as a DSA-enabled professional.

At the base of the model, the competencies apply to a large number of industries. As a user moves up the model, the competencies become industry- and occupation-specific. However, the graphic is not intended to represent a sequence of competency attainment or suggest that certain competencies are of greater value than others. Furthermore, the sequence of the competencies within the same level is not intended to suggest the sequence in which they should be taught.

Tiers 1 through 3 contain Foundational Competencies, which form the foundation needed to be ready to enter the workplace in DSA. Tier 4, containing Industry Competencies, illustrates the competencies specific to the *industry or industry sector*. These cross-cutting industry-wide competencies demonstrate the viability of career lattices that allow workers to move easily across industry sub-sectors. These Tiers are described in more detail below:

- **Tier 1 – Personal Effectiveness Competencies** are shown as hovering below the pyramid because they represent personal attributes that may present some challenges to teach or assess. Essential for all life roles, personal effectiveness competencies generally are learned in the home or community and reinforced at school and in the workplace.

- **Tier 2 – Academic Competencies** are critical competencies primarily learned in a school setting. They include cognitive functions and thinking styles that are likely to apply to most industries and occupations. This competency map assumes that the academic competencies are offered by a higher education institution, consistent with the definition of a DSA-enabled graduate presented below.
- **Tier 3 – Workplace Competencies** represent attributes, skills, and abilities, as well as interpersonal and self-management styles. They generally are applicable to a large number of occupations and industries.
- **Tier 4 – Industry-Wide Technical Competencies** represent the knowledge and skills that are common across sectors within a broader industry. These technical competencies build on, but are more specific than, competencies represented on lower tiers.

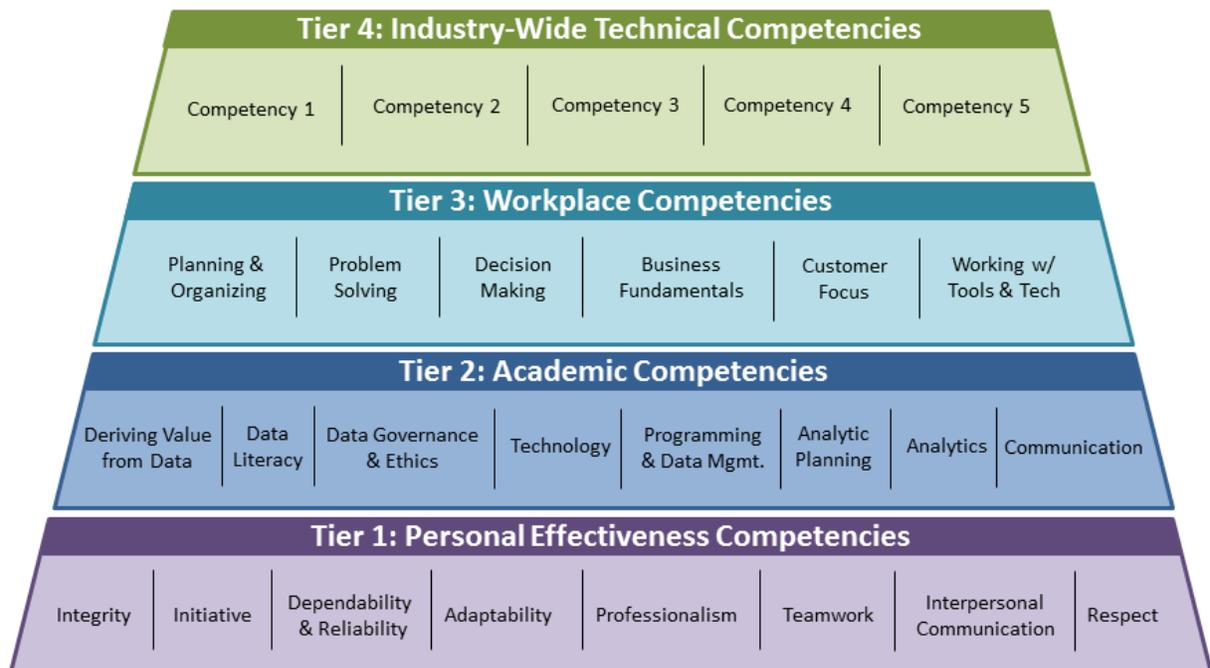
Development of the DSA-Enabled Competency Map

With this competency map model in mind, BHEF brought together more than 50 DSA subject matter experts from business, government, and higher education to develop Tier 2 (Academic Competencies) based on an agreed-upon definition of a DSA-enabled graduate (below). Tiers 1 and 3 are based on competencies developed by the National Network of Business and Industry Associations, with some supplementation by BHEF DSA stakeholders and information from the U.S. Department of Labor. Combined, these Foundational Competencies detailed in Tiers 1-3 are meant to equip a DSA-enabled graduate for entry into the workforce, irrespective of industry sector.

Definition of a DSA-Enabled Graduate

A student graduating from a postsecondary institution *enabled* in DSA has the individual and team skills necessary to identify appropriate data and request, consume, capture, and synthesize data and information to develop and communicate data-driven insights that drive value.

Competency Map for a DSA-Enabled Graduate



Foundational Competencies

Tier 1: Personal Effectiveness Competencies

1. Integrity: Treating others with honesty, fairness, and respect

- Demonstrate respect for company's time and property
- Accept responsibility for one's decisions and actions

2. Initiative: Demonstrating a willingness to work and seek out new work challenges

- Take initiative in seeking out new responsibilities and work challenges, increasing the variety and scope of one's job
- Pursue work with energy, drive, and effort to accomplish tasks
- Establish and maintain personally challenging but realistic, work goals
- Strive to exceed standards and expectations

3. Dependability & Reliability: Displaying responsible behaviors at work

- Behave consistently, predictably, and reliably
- Fulfill obligations, complete assignments, and meet deadlines
- Follow written and verbal directions
- Comply with organization's rules, policies, and procedures
- Demonstrate regular and punctual attendance

4. Adaptability: Displaying the capability to adapt to new, different, or changing requirements

- Be open to learning and considering new ways of doing things
- Actively seek out and carefully consider the merits of new approaches to work
- Embrace new approaches when appropriate and discard approaches that are no longer working
- Effectively change plans, goals, actions, or priorities to deal with changing situations

5. Professionalism: Maintaining a professional demeanor at work

- Demonstrate self-control by maintaining composure and keeping emotions in check even in difficult situations
- Maintain professional appearance by dressing appropriately for the job and maintaining personal hygiene
- Use professional language when speaking with supervisors, co-workers, and customers
- Maintain a positive attitude
- Take ownership of one's work

6. Teamwork: Demonstrating the ability to work effectively with others

- Establish a high degree of trust and credibility with others
- Interact professionally and respectfully with supervisors and co-workers
- Develop constructive working relationships and maintain them over time
- Use appropriate strategies and solutions for dealing with conflicts and differences to maintain a smooth workflow

7. Interpersonal Communication: Maintaining open lines of communication with others

- Demonstrate sensitivity and empathy
- Listen to and consider others' viewpoints
- Recognize and interpret the verbal and nonverbal behavior of others
- Speak clearly, in precise language and in a logical, organized and coherent manner
- Effectively use eye contact and non-verbal expression

8. Respect: Working effectively with those who have diverse backgrounds

- Demonstrate sensitivity and respect for the opinions, perspectives, customs, and individual differences of others
- Be flexible and open-minded when dealing with a wide range of people
- Value diversity of approaches and ideas

Tier 2: Academic Competencies**1. Deriving Value from Data: Understanding data as a resource and its potential applications for deriving value from data**

- Explain the importance of data and what data represents
- Demonstrate how data can be used to reduce uncertainty and risk related to business decisions and embedded decisions
- Reveal the risks of poor data management
- Identify problems that can be addressed with data
- Demonstrate importance and uses of metadata and indexing for data discovery, description, reusability, and information retrieval
- Explain rationale and demonstrate techniques for data transformations
- Identify examples of going from data to discovery to innovation

2. Data Literacy: Identifying common data sources, structures, and types

- Differentiate common data typologies, including structured vs. unstructured, numeric vs. text, root vs. derived
- Show the life cycle of data that includes value, time, space, and scale
- Identify sources of data used in data mining activities
- Identify common types of data used in domain-relevant analytics

- Explain different data organizational schemas and database management systems
- Explain potential uses/applications given a source and type of data
- Evaluate the impact of data organizational structures on data analysis

3. Data Governance & Ethics: Identifying data governance obligations and challenges and emerging legal and ethical data privacy and security best practices and uncertainties within a given context

- Explain the important issues around data governance
- Evaluate the data governance issues emanating from data flows (e.g. the Internet of Things; PII; aggregated data from multiple sources)
- Identify how legal, policy and/or ethical constraints might impact data analyses
- Evaluate some of the established ethical and legal issues in data management facing organizations
- Explain how ethical, compliance, and legal issues should/must be considered in data driven decision making
- Demonstrate awareness of personal privacy issues related to the collection and usage of data

4. Technology: Using information technology and related computer applications to convey and retrieve information

Databases

- Use a computer application to manage large amounts of information
- Create and edit simple data structures and storage
- Design databases and data systems that enable users to prepare, explore, and interpret data
- Implement common information retrieval and filtering applications in databases and data systems
- Implement advanced analytics methods in databases and data systems

Data Engineering Principles

- Describe the principle of data storage and processing using distributed computing
- Compare and contrast SQL and NoSQL platform
- Describe the issues and problems with the process of data extraction, transformation, and loading (ETL)
- Explain the value of creating a data repository to collect, store, manage, and understand patterns and trends in data
- Describe the role of different distributed platforms for storing data (e.g. Cassandra, MongoDB, Couchbase)
- Describe the role of different distributed platforms for data ingestion (e.g. Apache Kafka, Flume)
- Perform basic data querying on distributed platforms (e.g. Apache Hadoop, Apache Spark)
- Explain the MapReduce paradigm to resolve a problem on a distributed platform

5. Programming & Data Management: Identifying processes and mechanisms commonly used to retrieve, assess, re-engineer, enrich, manipulate, and amalgamate data and applying them appropriately

- Describe how data is organized and captured in a variety of industries and for different data sources
- Discuss key data assessment, re-engineering, and enrichment steps
- Summarize the general data due diligence process, requirements, and challenges
- Write data analysis code using modern statistical software (e.g., R, Python, and SAS)
- Perform basic data manipulation using appropriate tools and software
- Perform data summarization, sanity checks, and validation using appropriate tools and software
- Perform simple data exploration using appropriate tools and software

6. Analytic Planning: Evaluating requirements and specifications of problems to recommend possible analytics-based solutions

- Develop sound research questions around identified issues
- Identify, extract, and pull together available and pertinent data
- Assess data in terms of reliability and appropriateness to the possible solutions
- Evaluate the challenges and usefulness of multisource analytics
- Explain approaches to analyzing data sets, including “big data” sets
- Design experiments which include hypothesis-testing and problem-solving with data
- Demonstrate importance of design thinking in planning data analytics solutions for human consumption
- Demonstrate the process of user requirements gathering and use-case analysis
- Demonstrate differences between data science (analytics, hypothesis, testing) and data engineering (data storage, cloud, management)
- Demonstrate operationalization of fuzzy concepts to enable measurement and explain potential challenges to the validity of the analysis

7. Analytics: Applying designated quantitative techniques, including probability, statistics, optimization, and simulation to deploy appropriate models for prediction and analysis

- Demonstrate hypothesis testing and explain statistical significance
- Demonstrate and explain the role and importance of model validation and accuracy metrics in analytics projects, hypothesis testing, and information retrieval
- Differentiate among machine learning models (e.g., supervised and unsupervised learning, regression-type techniques)
- Differentiate among data analytic approaches (e.g., descriptive vs. diagnostic vs. predictive vs. descriptive analytics)
- Explain and demonstrate how differences in data and desired outcomes impact the appropriateness of data analysis techniques (e.g., descriptive vs. diagnostic vs. predictive vs. statistical)

- Interpret results from analysis in the context of the original problem
- Draw insights from results of analysis in the context of the original problem
- Explain the role of data visualization in discovery, communication, and decision-making

8. Communication: Designing and delivering presentations, reports, and recommendations that effectively translate technical results/data solutions and are coherent and persuasive to different audiences

Writing

- Write in a factual manner in a tone appropriate for the target audience in multiple formats
- Include an interpretation and/or articulate the implications of any analyses in non-technical language
- Document the analytics process for validation by others

Speaking and Presenting

- Express information to individuals or groups taking into account the audience and the nature of the information (e.g., explain technical concepts to non-technical audiences)
- Analyze an audience’s goals and requirements when proposing a project or solution
- Present ideas in a persuasive manner
- Track audience responses and react appropriately to those responses

Data Visualization

- Evaluate data visualization options for proper application in various situations
- Create effective data visualization reports or narratives that employ analytics and visualization software and strategies for various audiences

Tier 3: Workplace Competencies

1. Planning & Organizing: Planning and prioritizing work to manage time effectively and accomplish assigned tasks

- Plan and schedule tasks so that work is completed on time
- Prioritize various competing tasks
- Demonstrate the effective allocation of time and resources
- Take necessary corrective action when projects go off track

2. Problem Solving: Applying critical thinking skills to solve problems by generating, evaluating, and implementing solutions

- Identify and define the problem
- Communicate the problem to appropriate personnel
- Generate possible solutions
- Choose and implement a solution

3. Decision Making: Applying critical thinking skills to solve problems encountered in the workplace

- Identify and prioritize the key issues involved to facilitate the decision making process
- Anticipate the consequences of decisions
- Involve people appropriately in decisions that may impact them
- Quickly respond with a back-up plan if a decision goes amiss
- Recognize the benefits of a fast failure mentality
- Identify learning outcomes from successes and failures

4. Business Fundamentals: Having fundamental knowledge of the organization

- Understand the importance of one's role in the functioning of the company and the potential impact one's performance can have on the success of the organization
- Recognize the importance of maintaining privacy and confidentiality of company information, as well as that of customers and co-workers, and comply with intellectual property laws
- Understand the significance of maintaining a healthful and safe environment and report any violations/discrepancies to appropriate personnel

5. Customer Focus: Actively look for ways to identify market demands and meet customer or client needs

- Understand and anticipate customer needs
- Provide personalized service with prompt and efficient responses to meet the requirements, requests, and concerns of customers or clients
- Be pleasant, courteous, and professional when dealing with internal and external customers or clients
- Evaluate customer or client satisfaction
- Explain importance of UX (User Experience) and CX (Customer Experience)

6. Working with Tools & Technology: Selecting, using, and maintaining tools and technology to facilitate work activity

- Identify, select, and use appropriate tools or technological solutions to frequently encountered problems
- Carefully consider which tools or technological solutions are appropriate for a given job, and consistently choose the best tool or technological solutions for the problem at hand
- Operate tools and equipment in accordance with established operating procedures and safety standards
- Seek out opportunities to improve knowledge of tools and technologies that may assist in streamlining work and improving productivity