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Maximizing the Data Literacy of the Air Force Contracting Workforce

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ABSTRACT

In recent years, the U.S. government has increased its focus on the value of data and its associated technical specialties, artificial intelligence, and machine learning. This mixed-method study answers the question: How should the U.S. Air Force (USAF) align workforce data literacy development to contracting knowledge, skills, and ability requirements to deliver the appropriate content for mission-focused business leaders? Once identified, it asks: What are the most effective time, modality, and metrics for the delivery of this content? The data was collected through in-depth reviews of literature, 18 open-ended interviews of participants with varying degrees of exposure to data literacy, and qualitative and quantitative analysis of 47 different data-literacy-focused adult education curriculums. The analysis resulted in a potential data literacy training roadmap for the USAF contracting career field to consider implementing. Future researchers can conduct more in-depth research into ideal metrics for data literacy curriculums, and after identifying them, can look at potential programs and modalities best suited to accomplish those metrics. Another vein of research could be a case study review of emerging government data literacy programs, how they are implemented, and whether USAF contracting professionals can participate in them.

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LIST OF ACRONYMS AND ABBREVIATIONS

64P	Commissioned Contracting Air Force Specialty Code
6C0X1	Enlisted Contracting Air Force Specialty Code
ACES	awareness, comprehension, expertise and scaling
AF BICC	Air Force Business Competency Cell
AFICC	Air Force Installation Contracting Center
AFIT	Air Force Institute of Technology
AI	artificial intelligence
CBT	computer-based training
CFETPs	Career Field Education and Development Plans
CO	contracting officer
COTS	commercial off-the-shelf
CTs	competency topics
DAU	Defense Acquisition University
DAWIA	Defense for Acquisition Workforce Improvement Act
DOD	Department of Defense
EDA	Electronic Document Access
FCRA	Federal Cyber Reskilling Academy
FPDS-NG	Federal Procurement Data System-Next Generation
FY	fiscal year
GED	General Education Diploma
HQ	headquarters
IADQGA	International Association for Data Quality, Governance and Analytics
IBE	International Bureau of Education
IG	Inspector General
IT	information technology
JAIC	Joint Artificial Intelligence Center
KSAs	knowledge, skills and abilities
MAJCOM	Major Command
MFBLs	mission-focused business leaders

MIT	Massachusetts Institute of Technology
ML	machine learning
MLGs	mobile learning games
NCOIC	Non-Commissioned Officer in Charge
NDAA	National Defense Authorization Act
NDU	National Defense University
NPS	Naval Postgraduate School
OJT	on-the-job training
OL	operating location
OMB	Office of Management and Budget
PMA	President's Management Agenda
PMRT	Project Management Resource Tools
PRC	People's Republic of China
R&D	research and development
SAF/ACQI	Office of Contracting Business Systems
SECDEF	Secretary of Defense
SNCO	Senior Non-Commissioned Officer
SPO	System Program Office
USAF	United States Air Force

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First and foremost, I want to thank all of the Air Force professionals who participated in my research and shared with me their experiences and struggles with data literacy. Your varied experiences allowed me to gain insights that would otherwise have been lost. I hope that the results of my research end up benefiting your future experiences in contracting.

Of course, I need to acknowledge the unparalleled support and guidance that I received from my four-time professor and thesis advisor, Maj Daniel Finkenstadt. He listened to my incoherent thoughts and musings and formed them into a research project that I am very proud to have been a part of. My assistant advisor, Dr. Brett Josephson, also helped me immensely by bringing his AI and executive education expertise to my research efforts, all while being on the opposite U.S. coast.

Finally, I want to acknowledge all of the many experts who I was able to speak with either in classes or through informal conversations, who allowed me to get a grasp of the enormity of the challenge that attaining data literacy poses. While I cannot pretend to be magically data literate myself, even after a year of research, I can say I know more about it than I ever would have if it were not for your willingness to share your time and expertise with me. Thank you to all.

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I. INTRODUCTION

Sara Spivey, Chief Marketing Officer of Bazaarvoice, said in a 2018 interview with Forbes.com that "the rapid rise in our ability to collect data hasn't been matched by our ability to support, filter, and manage data" (Whitler, 2018, para. 3). This overabundance of data and inability to manage it effectively, or data saturation, has increased the demand for data literacy within the workforce. Unfortunately, the scramble to instill data literacy in the masses has led to disparate training models being implemented in companies across the country, which has led to some confusion about what skills are truly necessary to be data literate. This lack of a cohesive synthesized training model is not only apparent in industry, but also very true for the U.S. government, including U.S. Air Force (USAF) contracting. The General Accountability Office has identified the need for data stewardship as a critical success factor for acquisition activities within the federal government for some time (Woods et al., 2005). USAF contracting professionals have increasing access to a wide variety of valuable data as well as advanced tools available for data exploitation. Regrettably, a large population of these professionals appear to lack the skills necessary to use these tools and data to their full potential. This is the driving motivation behind my research, to provide a well-researched roadmap to help inform USAF contracting decision makers of the current state of data literacy content, method, timing and metrics. I hope that the information will prove useful in the design and implementation of future data literacy training programs for the USAF contracting workforce.

Daily data-driven decision-making is a common theme that has crept into the lives of executives and entry-level workers alike. In the U.S. military, this theme has become a focal point of numerous high-level strategic plans. The National Defense Authorization Act (NDAA) 2019 calls for defense services to identify "modern tools, methods, and approaches to readiness to more effectively and efficiently collect, analyze, and make decision [s] based on readiness data" (National Defense Authorization Act 2019, 2018, p. 98). This Act of Congress mentioned "data" 225 times and required the Secretary of Defense (SECDEF) to establish an education strategy for AI within the Department of Defense (DOD). This directive culminated in the 2020 DOD AI Education Strategy. This strategy identifies a set of critical competencies that the workforce must

have for AI adoption to be a success. Among the competencies are elements of an emerging concept that is the cornerstone of my research, data literacy, specifically, data literacy USAF contracting.

Data literacy is called many names throughout industry and the public sector. The DOD AI Education Strategy uses the terms "data management and visualization," while industry refers to this capability as data literacy (United States Department of Defense [U.S. DOD], 2020). Data literacy is a term that is sometimes controversial, as its counterpart "data illiteracy" has a very negative connotation. However distasteful this term may be to some; it is the dominant term within academia and industry so I have adopted this term for the purposes of this research. There is no definition in *Merriam-Webster*'s dictionary for the new and evolving concept of data literacy. *Merriam-Webster* currently defines literacy as having competence or knowledge regarding a subject or matter. Data can be defined as "factual information (such as measurements or statistics) used as a basis for reasoning, discussion, or calculation" or as "information in digital form that can be transmitted or processed." In the context of this research, we are talking about the latter digital information that may include the former factual information types. Instead, using qualitative theme analysis, which can be found in the data literacy definition section of this report, I determined that the definition from The International Association for Data Quality, Governance and Analytics (IADQGA) is best suited to meet my needs. This organization defines data literacy as "the ability to read, understand, create and communicate data as information. It also means the ability to create and interpret graphical representation of the data, draw conclusions from the data and recognize when data is being used in misleading or inappropriate ways" (Yacura, 2021, p. 12). I use this definition for assessing benefits to the USAF contracting career field from placing an emphasis on developing data literacy skills in its workforce.

A. U.S. GOVERNMENT DATA STRATEGIES RELATED TO DATA LITERACY

To formalize data advancement requirements detailed in the National Defense Authorization Act (NDAA), Congress required that agencies throughout the federal government produce and disseminate strategic data plans. These documents detail principles and practices that must be implemented to ensure data supremacy for each organization. They outline specific data

related goals as well as actions required to accomplish them. The following section contains summaries of published data strategies that directly affect USAF contracting.

B. FEDERAL DATA STRATEGY'S CALL FOR DATA LITERACY

A cross agency team focused on "leveraging data as a strategic asset" created the U.S. government's 2020 Federal Data Strategy and corresponding action plan (President's Management Agenda [PMA], 2020 p. 3). This plan set forth 40 practices that informed government agencies' actions for data management and created a set of goals to improve the U.S. government's strategy for leveraging data. The strategy breaks these practices into three categories: "building a culture that values data and promotes public use; governing, managing, and protecting data; and promoting efficient and appropriate data use" (PMA, 2020, p. 2). One of the last category's practices calls for the targeted training of the federal workforce in data management and analysis. It states that agencies must "educate and empower their workforce by investing in training, tools, communities and opportunities to expand capacity for critical data-related activities such as analysis, evaluation, data management and privacy protection" (PMA, 2020 p. 9). This practice directly relates to my definition of data literacy and shows that the federal level of our government finds value in investing in the workforce's data literacy skills.

C. DOD DATA STRATEGY'S CALL FOR DATA LITERACY

The DOD Data Strategy 2020 states that the DOD is moving toward a data-centric organizational structure and as such requires an increasingly empowered workforce to work with data and analytics. It demands that services provide data skills training, build centers for data engineering excellence, and create a culture that supports collaboration among data experts (DOD, 2020b). The strategy shows that the military has definite expressed interest in seeing the data literacy of its workforce increased through conscious effort.

D. ADDITIONAL DOD DATA LITERACY RELATED ACTION PLANS

Both our military and our near-peer counterparts are aggressively pursuing improving the national skillset in the AI field. China has published a national AI plan that shows it intends for the People's Republic of China (PRC) to become the world leader in AI by 2030 (Walzman et al.,

2020). In the NDAA, the U.S. government has demanded that the DOD become a change leader in American AI. To accomplish this, the DOD published a comprehensive AI Training and Education Strategy, with the goal of creating a data and AI capable military workforce. While military capability in this area is important, the plan is structured so that those desirable AI skills will also transfer to the American civilian workforce as service members transition out of military service. By making government employees more AI capable, the U.S. government believes it will help the U.S. workforce as a whole advance toward an AI centric future (U.S. DODa, 2020). Within this education strategy, the SECDEF has identified specific competency topics (CTs) that are critical to success in AI adoption. I used IADQGA's definition and qualitative analysis done on five academic studies on data literacy content, and I found that three of the eight CTs are directly related to data literacy. This indicates that data literacy is an important competency for the DOD's overall AI education plans as well.

E. DATA LITERACY IN USAF CONTRACTING

USAF contracting has already begun an effort to increase the data literacy of its workforce. The Data Literacy Campaign Team with Contracting Business Systems (within SAF/ACQI) was formed in 2020 in response to challenges posed by modernization of the contract writing system and demands for detailed procurement data to numerous stakeholders. Their goal is to "lower the barrier for change" for stakeholders to use the newest contract writing systems' data and to create and utilize business intelligence dashboards to make data-driven contracting decisions (CON-IT Data Literacy Campaign, PowerPoint Slides, September 2020). This campaign was formulated using the Forrester data literacy curriculum building model called Awareness, Comprehension, Expertise and Scaling (ACES). ACES breaks down the basic program objectives into three progressive phases with a fourth cycling phase (Arcand et al., 2020). The first level is *awareness*, which is accomplished by getting the population capable of recognizing the data, knowing how it adds value to business decisions, and understanding the need to protect it. The second level is *comprehension*, which requires the workforce to understand insights gathered from data and have the ability to apply them to their work for benefits to the business. The third phase is *expertise*, which is characterized by the demand for continuous insights to keep those hard-earned skills. The

final phase of this model is *scaling*, which requires the workforce to share their acquired skills and best practices throughout the contracting workforce (Belissent, 2020).

In the Department of Defense (DOD) AI Training and Education Strategy, each military service has been tasked with finding an existing industry solution for their workforce to attain required skills in the three data literacy CTs. While there is not yet a specified timeline, this requirement does pose a significant challenge to implement across all USAF career fields, due to the need to target training to job-specific data skills requirements. This is shown in a study from a RAND team that found that in DOD acquisition, data skills acquisition must be targeted to meet the requirements of each position, instead of simply training all members to the level of a data scientist (McKernon et al., 2020). What would it look like if the USAF contracting workforce were to incorporate a data literacy training program targeting both business intelligence data requirements as well as these DOD AI CTs? USAF contracting already has the challenge of handling complex training needs due to differing mission requirements, broad dispersion of personnel, varying acquisition processes and requirements, and a diverse mix of military and civilian contracting personnel. This leads me to my research questions.

F. RESEARCH QUESTIONS

- Research Question 1: How should the USAF align workforce data literacy development to contracting knowledge, skills and ability requirements to deliver the appropriate content for Mission-Focused Business Leaders (MFBLs)?

- Research Question 1(a): Once identified, what is a potential time and modality for the delivery of this content?

- Research Question 2: What are some uncovered best practice methods for the USAF contracting career field to take into consideration?

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II. LITERATURE REVIEW

Because of data literacy's evolving and nuanced definition, I compared existing definitions to decide on a single definition for data literacy to be used within the context of this research. After defining data literacy, I was able to address my research questions' key themes: data literacy content, data literacy timing, methods of training delivery and data literacy metrics. For clarity, I have included my working definitions for data literacy and each of these associated themes in Table 1.

Table 1. Key Terms and Definitions

Data Literacy	"The ability to read, understand, create and communicate data as information. It also means the ability to create and interpret graphical representation of the data, draw conclusions from the data and recognize when data is being used in misleading or inappropriate ways" (Yacura, 2021, p 12).
Content	"The knowledge, skills and attitudes imparted by learning areas/subjects, cross-cutting approaches and extra-curricular activities" (International Bureau of Education, 2016, para.1).
Timing	The point in a contracting professional's career when they are expected to be exposed to and attain a specific set of data literacy skills.
Method	The means, techniques and approaches to deliver and impart educational content. These are most often categorized as traditional (in-person), online synchronous, online asynchronous. However, there are other methods explored in this paper, such as microlearning and mobile game learning.
Metrics	"Measures that provide you with the quantifiable information you can use to track performance or progress" (Stanford University [SU], n.d., para.1).

A. DEFINITION OF DATA LITERACY

In my research, I reviewed 11 definitions provided by experts in the fields of data analytics, education andragogy, business, and library science. Table 2 shows the definitions reviewed as well as the experts' stated field of focus for the research. I then performed qualitative analysis in the form of thematic coding to identify common key themes within these definitions. To do this, I took out keywords or concepts identified as components of data literacy. For example, for Prado and

Marzal's (2013) definition, I noted key concepts to be access, interpret, assess, manage, handle, and ethics. After completing this initial coding for each definition, attempting to keep like concepts as uniform as possible, I combined these terms into a single list counting each instance of a key concept, such as assess, from all 11 definitions. Finally, I used these compiled word counts to create Figure 1, which shows the visualization of this analysis. This reveals three key repeated concepts:

1. Ability to communicate and interpret data,
2. Acquisition of skills necessary for user to access and
3. Use of the data to make data driven decisions and finally the competence to assess, understand and analyze data.

Table 2. Data Literacy Experts Definitions

Author	Field of Focus	Definition
Prado & Marzal	Information Literacy, Library Science	"Data literacy can be defined, then, as the component of information literacy that enables individuals to access, interpret, critically assess, manage, handle and ethically use data" (Prado & Marzal, 2013, p. 126).
Schield	Information Literacy, Library Science	"Data literacy is the part of statistical literacy that involves training individuals to access, assess, manipulate, summarize and present data, whereas statistical literacy aims to teach how to think critically about descriptive statistics" (Schield, 2005 p. 6).
Qin & D'Ignazio	Science	"Science data literacy (SDL) emphasizes the ability to understand, use, and manage science data" (Qin & D'Ignazio, 2010a, p. 3).

Author	Field of Focus	Definition
Handfield et al.	Business, Supply Chain Management	"Data literacy is the ability to derive meaningful information from data. It is the ability to read, understand, create, and communicate data as information. A secondary significance of data literacy is that it increases an individual's responsibility for collecting, integrating [,] interpreting, sharing and acting upon available data. The lack of data literacy prevents effective communication with a common level of data understanding amongst internal and external data users" (Handfield et al., 2020, p. 3).
Usova & Laws	Information Literacy, Library Science	"Data literacy is the ability to find, analyse, interpret and effectively communicate data and key insights derived from it" (Usova & Laws, 2021, p. 84).
Martin	Library Science	"Data literacy is "the ability to read, create, and communicate data as information" (Martin, 2014, p. 1).
Yacura (IADQGA)	Business, Supply Chain Management	"Data literacy is the ability to derive meaningful information from data just as literacy in general is the ability to derive information from the written word. Data literacy is typically defined as the ability to read, understand, create and communicate data as information. It also means the ability to create and interpret graphical representation of the data, draw conclusions from the data and recognize when data is being used in misleading or inappropriate ways. The complexity of data analysis, especially in the context of big data, means that data literacy requires some knowledge of mathematics and statistics" (Yacura, 2021, p. 12).
Mandinach & Gummer	Educator Learning	"Data Literacy is the ability to understand and use data effectively to inform decisions. It is composed of a specific skill set and knowledge base that enables educators to transform data into information and ultimately into actionable knowledge" (Gummer & Mandinach, 2013, p. 30).
MIT SMR Connections	Data Analytics, Business	"Data analytics skills in the workforce" (Massachusetts Institute of Technology [MIT], 2019, p. 16).
Mandinach & Gummer	Educator Learning	"The ability to transform information into actionable instructional knowledge and practices by collecting, analyzing, and interpreting all types of data (assessment, school climate, behavioral, snapshot,

Author	Field of Focus	Definition
		longitudinal, moment-to-moment etc.) to help determine instructional steps. It combines an understanding of data with standards, disciplinary knowledge and practices, curricular knowledge, pedagogical content knowledge, and an understanding of how children learn" (Gummer & Mandinach, 2015, para. 6).
Bradshaw	Social Science	"Data literacy is a process that involves different competencies at each step; on the consumption side, it's an acumen in judging the credibility of a final product. On both sides it's an understanding of the fundamental problems that can crop up along the way, from strategy to data collection to filtration to analysis to presentation" (Bradshaw, 2014, para. 6).

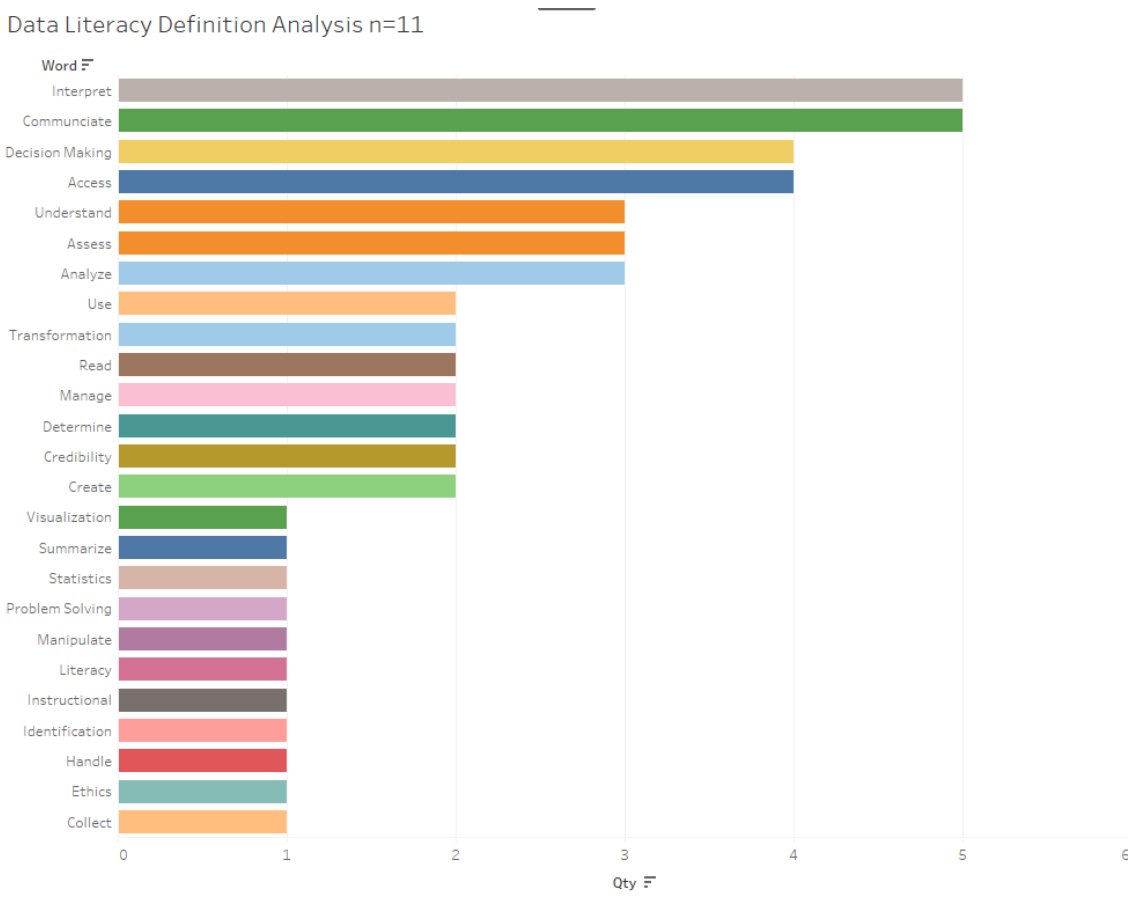

Figure 1. Data Literacy Definition Analysis

With these trends in mind, I found the definition given by the non-profit IADQGA the most comprehensive and succinct. It defines data literacy as "the ability to **read**, **understand**, **create** and **communicate** data as information. It also means the ability to **create** and **interpret graphical representation** of the data, **draw conclusions** from the data and recognize when data is being used in misleading or inappropriate ways" (Yacura, 2021, p. 12). I propose that the USAF contracting career field adopt this definition if it chooses to move forward with investing in educating in this realm. This definition both informed my interview questions and overall methodology. The key distinguisher between this and many provided definitions is the call for avoiding misleading or inappropriate representation of data (Yacura, 2021). As a government entity and tax funded institution, it is imperative that the USAF contracting members perform their duties to the utmost of their ability and do not use data literacy skills to misrepresent data for individual gain or misinterpret when others may be doing so. It is important to include this aspect of the definition because it ensures that the expectation is immediately set that USAF members will use acquired data literacy skills appropriately.

B. CONTENT

The first of my research questions' four themes for literature review is content. I reviewed publications from academia and the government on expected data literacy curriculum content. Table 3 shows a summary of what curriculum content eight academics and two non-profit institutes suggest as necessary for a robust data literacy program.

Table 3. Expert Recommended Data Literacy Curriculum Content

Author	Recommended Data Literacy Curriculum Content
Carlson et al.	"Discovery and acquisition of data, data management and organization, data conversion and interoperability, quality assurance, metadata, data curation and re-use, cultures of practice, data preservation, data analysis, data visualization, ethics, including citation of data" (Carlson et al., 2011, p. 652)
Prado & Marzal	"Understanding data, finding and or obtaining data, reading, interpreting and evaluating data, managing data, using data" (Prado & Marzal, 2013, p. 130)

Author	Recommended Data Literacy Curriculum Content
Kafel	"Overview of research data management, data, types, stages and formats, metadata, data storage, backup, security, legal and ethical considerations, data sharing and re-use policies: access levels, plan for archiving and preservation of data" (Kafel, 2012, p.2)
Open Data Institute (ODI)	"Innovating with data to include designing services and achieving sustainability, managing change/risk through governing access, working ethically, building communities and measuring success, leading change by prioritizing action, developing strategy and creating policy, introducing data with focuses on classification, creating value, and boosting data usability, standardizing data by teaching data cleaning and linking skills as well as platform usage capabilities, interacting with data using trend analysis, data analytics, data visualization and making data intelligent" (Open Data Institute, 2020, p. 2)
IADQGA	"Basic data awareness, importance of data quality, working knowledge and understanding of basic data concepts, classification and terminology, basic data collection techniques, basic descriptive statistics, basic predictive statistics, statistical result interpretation, basic statistical result communications & visualization" (IADQGA, n.d., para. 5)

These content items are further analyzed using thematic coding in the analysis section to show prominent themes across academia and how they relate to government data literacy expectations. In addition to these expectations, I performed qualitative analysis on 47 executive education programs with content related data literacy. A summary of these findings is found in the results section of this paper.

It is also necessary to revisit and expand on the CTs found within the DOD AI education strategy and their relation to data literacy. I used IADQGA's definition and thematic coding qualitative analysis, found in the data literature qualitative analysis section of this paper, on the five academic studies discussed previously to identify which DOD AI CTs were directly related to data literacy. I found that three of the eight CTs had descriptions that were related to prominent themes in data literacy content. CT3, data management and visualization and its subcategories:

managing data, visualizing data and data preparation, relate closely to both the most dominantly recurring themes in academia for content and IADQGA's definition. CT4, responsible AI, calls for employees to operate ethically and legally. These are also key elements of my chosen data literacy definition. Finally, CT6, mathematics, statistics, and data science are heavily recurring themes across academic content and foundational concepts for many data literacy skills. Figure 2 shows all the stated CTs from the DOD AI Training and Education Strategy for reference (U.S. DOD, 2020a).

Competency Topic	Competencies
1 Foundational Concepts	• **Understanding AI:** Conceptualizing probabilistic reasoning and core elements of AI stack (to include Natural Language Processing, Natural Language Generation, Natural Language Understanding, Computer Vision, Neural Networks, Deep Learning, Computer Vision, Robotics, and Autonomous Operations) • **Applying AI:** Interpreting AI output and recognizing potential use cases, as well as understanding the basic requirements successful application • **Advanced AI concepts:** Understanding advanced and state-of-the-art AI methods
2 AI Applications: Opportunities and Risks	• **Identifying trends:** Recognizing emerging trends in AI, as well as opportunities for research • **Identifying risks:** Recognizing data and network security and privacy risks that come with AI, as well as AI bias, complementary compliance, incident response policies, and unique challenges to DoD (e.g., doctrine, warfighter displacement/dependence on machines, explainable AI, and trust)
3 Data Management and Visualization	• **Managing data:** Understanding how to collect, store, and monitor data • **Visualizing data:** Knowing how to structure and display data, as well as use data to create a story • **Data preparation:** Preparing structured or unstructured data so that it is usable and meaningful to models
4 Responsible AI	• **Operating ethically and legally:** Understanding the ethical issues related to AI and adhering to all relevant regulations
5 Infrastructure, Coding, and Software Development	• **Programming and scripting:** Knowing how to code in languages that support AI tool development and data analysis, e.g., Java, Python, SQL • **Software engineering:** Understanding how to build effective software in the most efficient manner, including knowledge of DevOps, full stack development, and integration of established algorithms and pre-trained models • **Operating in cloud:** Understanding various cloud services, cloud-native architectures, orchestration tools • **Computing:** Understanding basic computing concepts (e.g., fog computing), and being able to differentiate different forms of computing • **Testing AI:** Using models and prediction methods for evaluating AI performance • **DevSecOps:** Understanding the tools and infrastructure needed to automate development, testing, securing, and deploying AI/ML-enabled software into the DoD • **AI frameworks:** Understanding of the common frameworks used to implement AI methods
6 Mathematics, Statistics, and Data Science	• **Performing analysis:** Applying mathematical and statistical analysis, (e.g. customized models / algorithms, predictive analytics) to understand and engage AI at technical level
7 AI Delivery	• **Managing product development:** Understanding AI project management, including product development & prototyping • **Overseeing AI delivery:** Understanding management of an AI delivery team, the structure and operating model, and effective planning, as well as how to facilitate the implementation of these tools by end users • **Leading AI strategy:** Knowing best practice for implementing AI on a large scale as well as AI's impact on strategy
8 AI Enablement	• **User-centric design:** Integrating Design Thinking, human-centered design, UX / HCI into system development & deployment • **Legal/IP Rights:** Understanding of data rights, property rights, and intellectual property

Figure 2. DOD AI Strategy AI Competencies. Source: U.S. DOD (2020a).

C. TIMING

1. DOD Data Education Timing Requirements

The topic of data literacy timing addresses the point in a professional's career when they are expected to be exposed to and attain a specific set of data literacy skills. Optimal timing is a complex concept and should be tailored to an organization's structure. In the DOD AI Training and Education Strategy, the Joint Artificial Intelligence Center (JAIC) has defined an initial structure to categorize members into groups called JAIC archetypes (U.S. DOD, 2020a). AI timing directly relates to data literacy timing because the current state of U.S. government efforts in AI revolves around establishing a data literate workforce capable of eventually implementing more advanced AI initiatives. Since data literacy is foundational to AI competence, I use the AI timing to inform my research question theme of timing for data literacy. These archetypes are Employ AI, Facilitate AI, Embed AI, Create AI, Drive AI and Lead AI. Figure 3 shows the archetype, its description, workforce concentration and an explanation of their roles.

Archetype	Description	Concentration	Role Explanation
Lead AI	Decides policy and doctrine, including how AI tools can or will be used; builds AI vision and plan	Policy	• Creates overarching guidance on DOD AI use
		Command	• Ensures AI policy carried out by personnel they lead
		Agency/Function Lead	• Ensures AI policy carried out in non-combat agencies
Drive AI	Ensures appropriate AI tools and capabilities are developed and delivered across DOD	Acquisitions Manager	• Supports technology/capabilities through total life cycle
		Capability Manager	• Evaluates and develops force structure resources and reqs
		Technical Manager	• Defines the tech strategy across a project portfolio
		Product Manager	• Ensures the creation of AI-enabled tools, from start to finish
Create AI	Creates AI tools to meet current and future needs	AI Researcher	• Pushes DoD AI capability by preparing for future use cases
		AI/ML Engineer	• Builds, tests, codes, integrates, and delivers AI tools
		Testing & Evaluation Engineer	• Evaluates system capabilities, limitations, operational risks
		Data Scientist	• Applies AI tools to perform analytics and create solutions
		Deployment Engineer	• Manages integration, deployment, and operation of AI systems
Embed AI	Embedded with Employ AI, establishes AI systems and provides end-user support at tactical edge	Technician	• Deploys, maintains, adapts, and collects data for AI/ML systems at the tactical edge
Facilitate AI	Represents users to ensure appropriate AI tools are developed and delivered to address use cases	Product Owner	• Provides voice of customer; turns product vision into backlog
		UI/UX	• Designs AI tool interface for usability and accessibility
		Other Technical Experts	• Delivers discrete elements of system not specific to AI
Employ AI	End-users of AI tools, provide feedback on and requirements for AI tools	Operations	• Prepares for and delivers operational requirements
		Intelligence	• Gathers and analyzes info to support decision-making
		Logistics & Maintenance	• Enables troop / gear movement, maintain equipment
		Health	• Maintains health and wellbeing of the Warfighter
		Support	• Supports the Warfighter in non-combat requirements

Figure 3. AI Workforce Archetypes and Concentrations. Source: DOD (2020a)

.

For the scope of this research the two that apply to data literacy and USAF contracting are Employ AI and Drive AI (U.S. DOD, 2020a). The Employ AI archetype is applicable because it encompasses end-users of AI tools that give feedback on tools and their mission requirements. It includes those members who work operations, intelligence, logistics and maintenance, health, and support missions. The Drive AI archetype is applicable because its members ensure that the correct AI tools and capabilities are developed and delivered across the DOD. They include acquisition managers, capability managers, technical managers, and product managers who support the necessary AI technology throughout its life cycle and contracting professionals who work closely with these mission partners. The other archetypes, such as facilitate AI, Embed AI, and Create AI, do not directly apply to traditional contracting personnel, as the roles are targeted toward members of the information technology (IT) workforce who provide technical support AI product usage, maintain and collect data for AI/ML systems, or design and maintain advanced AI programs. The lead AI archetype could theoretically apply to certain general officer positions, which may demand creation of AI policy or execution of this AI on a large scale, but that would include a small, niche group that can be explored outside the scope of this generalized research.

The JAIC has also defined four curriculum levels of topic area understanding to further distinguish the standard to which each archetype is expected to be trained (U.S. DOD, 2020a). The first level is "No requirement." The second, "basic level," relates to an "advanced beginner." This level necessitates comfort with working independently in the competency. "Intermediate level" is a member who can perform all the basic level tasks as well as mentoring others. "Advanced level" correlates to being completely proficient in the competency and having a superior level of skill with which to inspire and train others.

Employ AI archetypes for both CT3 and CT4 are expected to attain a basic level of understanding in the base and subcategories. CT6 does not have even a basic requirement for the Employ AI archetype. Drive AI archetypes for CT3 and CT4 are expected to reach the intermediate level in all CT3 subcategories and demonstrate the ability to use data visualization tools and prepare data for ML applications. For the CT4 this expectation means an ability to mentor others in the ethical use of AI and appropriate regulations. CT6

expects members of the Drive AI archetype to achieve a basic level of understanding of statistical analysis and AI technical comprehension. Figure 4 shows a summary of the key AI education strategy's data literacy archetypes and their expected level of mastery (U.S. DOD, 2020a).

	CT3 Data Management & Visualization			CT4 Responsible AI	CT6 Math, Stats, and Data Science
Archetype	Manage Data	Visualize Data	Data Prep	Operate Ethically	Perform Analysis
Employ AI	B	B	B	B	N
Drive AI	M	M	M	M	B

Key: N = No Requirement; B = Basic Level; M = Intermediate Level; A = Advanced

Figure 4. AI Competencies and Level of Topic Area Understanding. Adapted from U.S. DOD (2020a).

In addition to this military document, academia has some recommendations for military organizations attempts to optimize timing of their data literacy efforts. J. Darren Duke, a former Marine Corps officer who publishes AI related content for the Marine Corps Gazette, recommends that the DOD set minimum requirements for the accession of officers. He believes all military officers should have completed data literate and AI focused coursework prior to commission. He suggests a data analysis coursework set of economics and statistics (Duke, 2021). It must be noted that this would be a requirement that if adopted, could only be leveraged against the officer corps, as currently the USAF does not require enlisted accessions to complete any collegiate work. This requirement for enlisted members would most likely include incorporation of data literacy training into the existing contracting technical school curriculum.

2. USAF General Education Timing Requirements

In addition to the DOD overall guidance for all uniformed members from the JAIC document, I accounted for the career progression expected of both enlisted and officer USAF contracting professionals. There are two key documents that guide a contracting professional's career and skills development. The first of these documents is the USAF Career Field Education and Development Plans (CFETPs), which outlines the typical career path of a contracting professional. The CFETP for enlisted is titled Career Field Education and Training Plan 6C0X1 and the CFETP for officers is titled Career Field Education and Training Plan 64P (USAF, 2017). Within these documents the USAF sets expectations, depicted as a pyramid, for rank progression, professional military and contracting education acquisition, and likely contracting position progression. (USAF, 2017). Figure 5 is an example for the enlisted career field.

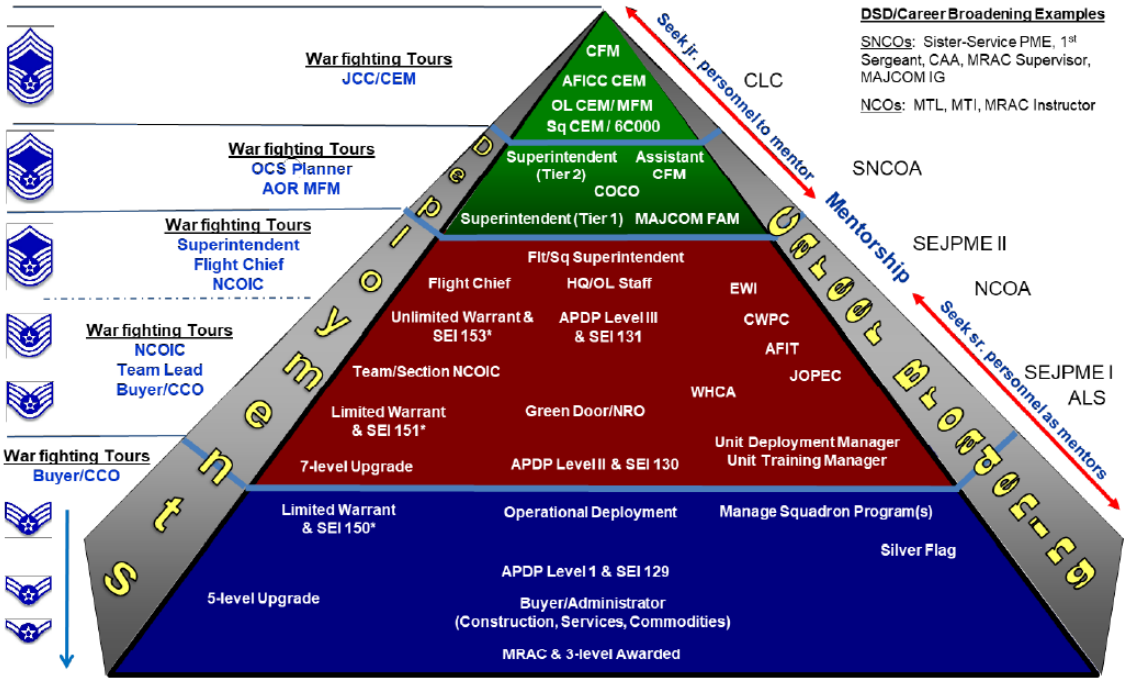

Figure 5. Contracting Career Field Progression Pyramid. Source: USAF (2017).

3. USAF Contracting Data Education Timing Requirements

The second guiding document, "The Gold Standard," is a critical new structure that USAF contracting leadership is using to set expectations for data comprehension requirements and timing expectations for the contracting workforce. This document consolidates the set of competencies known as Knowledge, Skills and Abilities (KSAs) and associates them with proficiency levels in various key contracting positions (Wright & Cillo, 2021). There are six main KSAs defined in Table 4; mission-focus, leadership, business acumen, relationship management, critical thinking, and technical skills (Wright & Cillo, 2021). The Gold Standards narrative document also has a complementary section for policy, guidance, and tools currency.

Table 4. Gold Standard KSA Definitions. Adapted from Wright and Cillo (2021).

Gold Standard KSA	KSA Definition
Mission-Focus	The practice of linking what we do every day to the big picture mission of the AF/DOD while relentlessly focusing on Mission Partner needs
Leadership	Developing personal responsibility, leading others, and impacting your organization (and even up to the enterprise level)
Business Acumen	Understanding basic business principles, contractor motivations, and industry trends in order to craft better business deals
Relationship Management	All the ways you interact with others; through communication, collaboration, resolving conflict, and showing emotional intelligence
Critical Thinking	Deliberately interpreting and analyzing situations, making inferences, and effectively solving problems or improving processes
Technical Skills	Developing the bedrock skills of the Contracting profession that allow us to turn dollars into products and services for our Mission Partners

Within the details for each of the KSAs, two of these six have expressed specific skills requirements related to data literacy: technical skills, and leadership. In addition to this, the complementary section for policy, guidance and tools currency has instances of

data literacy requirements as well. In the leadership KSA, this can be seen as a demand for data-driven decision-making competency. For the technical skills KSA, this manifests as a requirement for data analytics skills and in the policy and tools complementary category it is found as a requirement for data and metrics exploitation from existing business intelligence tools.

For USAF contracting Gold Standards, the level of proficiency required for each area increases along a set scale that is further divided into subcategories of knowledge and skills/abilities. See Table 5 for the USAF's further explanation of this scale.

Table 5. Proficiency Rating Scale Definitions. Adapted from Wright and Cillo (2021).

Proficiency Rating Level	**Definition**
Awareness	For knowledge: The individual is conscious of, acquainted with, informed of/about, familiar with, or has knowledge and perception of a situation or fact. Able to discuss a task topic and be aware of its meaning For skills/abilities: The individual can do simple parts of the task, but needs to be told or shown how to do most of the task.
Demonstration	For knowledge: The individual can give an explanation of how a process, skill, or task is performed For skills/abilities: The individual can do simple parts of the task and needs help only on the hardest parts. Should be effective, but may not be fully efficient. Can tell or show others how to do the simple parts of the task.
High Proficiency	For knowledge: The individual is able to not only apply the skill, but analyze it and relate it to other parts of the relative process, as well as make judgments based on standards and criteria. For skills/abilities: The individual can do all parts of the task and needs only a spot check of completed work. Is both effective and efficient and can tell or show others how to do the task.
Mastery	For knowledge: The individual is able to not only evaluate and make judgments about a topic, but also show the ability to synthesize elements of the process for long-term decision-making, as well as create and advise on strategies for all stakeholders. Can identify the long-term or overall aims and interests and the means of achieving them

Proficiency Rating Level	Definition
	For skills/abilities: The individual can do the full task completely and accurately and can tell or show others how to do the task. Has mastered the skill and uses it strategically.

Table 6 further breaks down officer and enlisted contracting positions into a progression spectrum. For officers, it flows; operational buyer, systems buyer, unlimited warrant contracting officer (CO), Branch Chief, Air Force Installation Contracting Center (AFICC), Major Command (MAJCOM) Staff, Squadron Commander, System Program Office (SPO) Tier 1, Air Staff, Joint Staff, AFICC Operating Location (OL) Director, Center PK. For enlisted it progresses; contract specialist, Non-Commissioned Officer in Charge (NCOIC), Team Lead (Warranted CO), Headquarters (HQ) Staff NCO, Warranted CO ($5M – Unlimited), MAJCOM Inspector General (IG), HQ Staff Senior Non-Commissioned Officer (SNCO), Superintendent, and finally Chief Enlisted Manager. Table 6 also summarizes the Gold Standard's key data literacy related KSAs and the skills proficiency rating level requirement for each of these positions.

Table 6. Data Technical Skills Positional Requirements & Proficiency Level. Adapted from Wright and Cillo (2021).

Position		Proficiency Rating Level Required (Data Related)		
Officer		Policy/Guidance/Tools Currency	Technical Skills	Leadership
	Operational Buyer	Demonstration	None Listed	None Listed
	Systems Buyer	High Proficiency	Highly Proficient	None Listed
	Unlimited Warrant CO	High Proficiency	Mastery	Highly Proficient
	Branch Chief (Center)	High Proficiency	Mastery	Highly Proficient
	AFICC/MAJCOM Staff	Mastery	None Listed	Highly Proficient
	Squadron Commander	Mastery	Mastery	Mastery
	SPO Tier 1	Mastery	Mastery	Mastery
	Air Staff	Mastery	None Listed	Mastery

Position		Proficiency Rating Level Required (Data Related)		
	Joint Staff	None Listed	None Listed	Mastery
	AFICC OL Director	Mastery	Mastery	Mastery
	Center PK	Mastery	Mastery	Mastery
Enlisted	Contract Specialist	Demonstrates	None Listed	None Listed
	NCOIC	Highly Proficient	Highly Proficient	None Listed
	Team Lead (Warranted CO)	Mastery	Highly Proficient	Highly Proficient
	HQ Staff NCO	Highly Proficient	None Listed	Highly Proficient
	Warranted CO ($5M-Unl)	Highly Proficient	Mastery	Highly Proficient
	MAJCOM IG	None Listed	None Listed	Highly Proficient
	HQ Staff SNCO	Mastery	None Listed	Highly Proficient
	Superintendent	Mastery	Mastery	Mastery
	Chief Enlisted Manager	Mastery	Mastery	Mastery

This analysis does have its limitations. While the enlisted and officer corps make up significant contributing members of the contracting community, the civilian workforce is the largest proportion and a driving and consistent force within USAF contracting. The omission of their career paths in this table is due to the wide variety of possible career progression options available to them. Civilians can often start working in both operational and system contracting and have varying degrees of expertise gained in education. As such it is not possible to represent their career paths in the same manner and should be considered in future studies.

4. Data Literacy Timing in Industry

A team of supply chain management experts sampling the data literacy of various organizations observed that companies find data literacy to be essential for optimization, yet they train their employees very sporadically. Figure 6, taken from their study, shows that only 17.5% of U.S. companies self-identify as advanced in data literacy. Figure 7

indicates that there is improvement in an organizations data literacy as its revenue increases, but even in companies with revenue exceeding $10 billion annually, only 28.6% consider themselves advanced and 21.4% identify as extremely limited. This study recommends such organizations have a targeted and purposeful development of data literacy within an organization, and that is customized to its structure (Handfield et al., 2020). The USAF expects to have a budget of $156.3 billion fiscal year (FY) 2022 (Air Force Financial Management & Comptroller., 2021). According to the USAF's Business Intelligence Tool, in FY2020, the USAF obligated almost $78B in contracts (Air Force Business Competency Cell [AF BICC],2021). There is no apparent reason not to expect the USAF to have, or to attain, a workforce data literacy comparable to those companies in the greater than $10 billion revenue range.

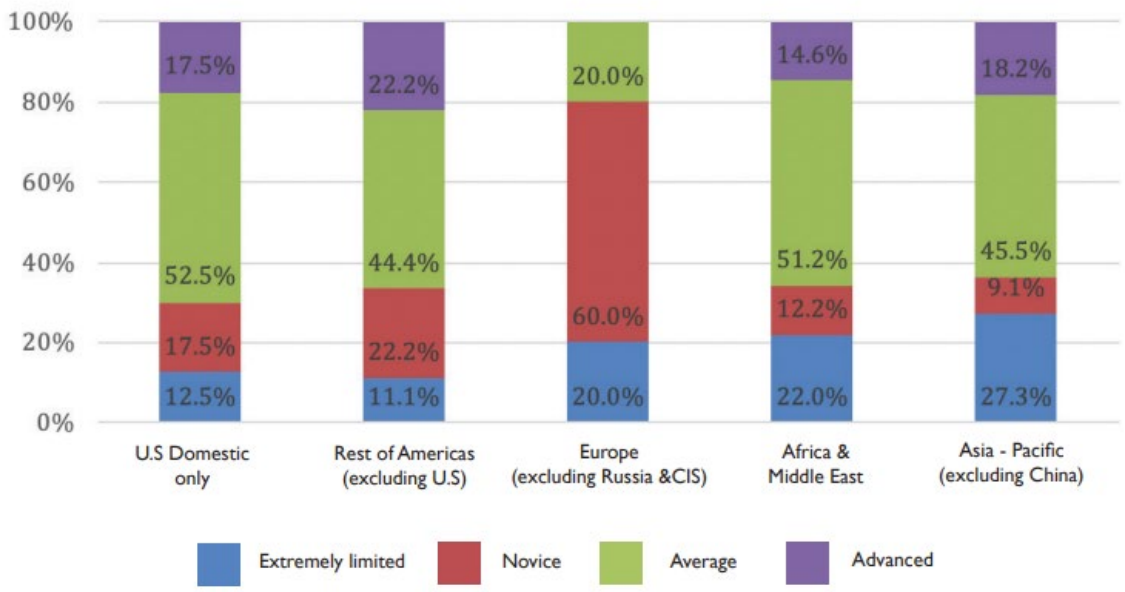

Figure 6. Data Literacy across the World. Source: Handfield et al. (2020).

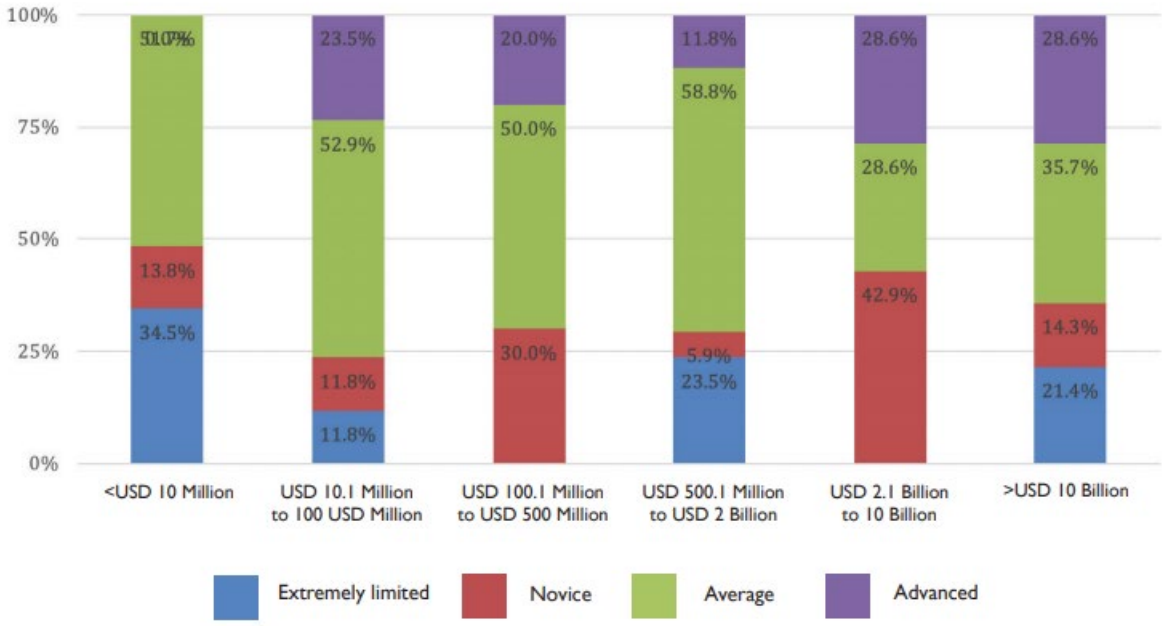

Figure 7. Data Literacy by Revenue. Source: Handfield et al. (2020).

5. Data Literacy Timing by Positions/Roles

There are different levels of data required depending on the position one inhabits. According to Kozyrkov (2018), analysts, statisticians and decision makers are all different levels of the data information structure, and their required outputs and skills vary. An analyst is not meant to tell a decision maker what data means, only to provide it to them to make an educated decision based on their expertise, position, and personal level of data literacy (Kozyrkov, 2018). This principle agrees with the USAF's current "Gold Standard Model," as a member's data skills progress as they progress in rank and position. The DOD AI Education Strategy also expects members to move from one archetype to another based on position, and each archetype has varying degrees of competence required (U.S. DOD, 2020a). Overall, this tells us that to be effective, training must be customized to the member throughout their career and should not rely on singular mass training events to bring an organizations' data literacy to appropriate levels.

D. METHOD

Of the research question themes, data literacy delivery methods is the most robust in terms of available academic research. Many of these studies focused on primary education, but this review focuses on studies that concentrate on adult education. Most members of the military are at least 17 and have completed their primary education or acquired a General Education Diploma (GED). I focused my research on trying to identify optimal and emerging education methods that I can use in my proposed data literacy roadmap. All studies that I found that showed efficacies of training, used traditional in-person training as the control group to compare with. While other methods of delivery exist outside of traditional and e-learning, the preponderance of the available COTS training and academic research surrounds these two methods, so I limited my methods section literature review to these.

1. Foundational Background on Educational Frameworks

To understand methods of training, it is necessary to touch on some foundational background for educational strategies and frameworks. One of the most broadly used and accepted frameworks is "Bloom's Taxonomy." This framework identifies six major categories in the cognitive domain, structured from the simplest to the most complex, and from the most concrete to the most abstract (Krathwohl, 2002). These categories are most often depicted as a pyramid in the following order (bottom to top, simplest to most complex): knowledge, comprehension, application, analysis, synthesis and evaluation (Krathwol, 2002). As the pyramid structure suggests, each simpler category requires mastery to progress to the next more complex one. This taxonomy classifies learning objectives for curriculums across the categories. Almost always this analysis has found that education curriculum objectives require only the most basic cognitive domain mastery, knowledge (Krathwohl, 2002). This level, however, falls short of the real desired objectives of most education, which is the comprehension, application, analysis, and synthesis domains (Krathwohl, 2002). This is important to understand, not only because Bloom's taxonomy is referenced extensively in research on learning effectiveness, but also because the USAF contracting career field must ensure that its data literacy objectives go beyond

the knowledge level. Selecting programs or training solutions must also address the cognitive domain they desire to attain.

2. Understanding E-Learning

E-Learning "generally refers to internet-based forms of learning, rather than face to face interaction and where traditional methods of learning are supported by online resources" (Sohrabi, 2016, para. 1). Most of academia has adopted this term to replace the formerly prominent terminology of computer-based training (CBT). E-Learning breaks down into two distinct categories, asynchronous learning, and synchronous learning. Asynchronous e-learning uses internet-based tools, such as email and discussion boards, but caters to students who cannot be online at the same time. Synchronous e-learning uses tools such as videoconferencing and chat and occurs with all students and educators interacting live (Hrastinksi, 2008). A team from the University of Tehran conducted a literature review and compiled Table 7 (Sohrabi et al., 2018). This table summarizes the advantages of e-learning as stated by eight teams of industry expert. Flexibility of time and location, cost-effectiveness, learner-centered, and archival capability for knowledge reuse and sharing are the most frequently cited advantages. These advantages are important to understand when determining what the optimal method of data literacy training is for the is for USAF contracting career workforce.

Table 7. Advantages of E-Learning by Author. Adapted from Sohrabi et al., (2018).

Advantages of e-learning	Roffe (2002)	Wang (2003)	Zhang et al. (2004)	Mitchell & Honore (2007)	Chen (2008)	McKenzie & Murray (2010)	Huang et al.(2011)	Mohammadi et al. (2011)	Total
Flexibility (of time and location)	●	●	●	●	●		●	●	7
Cost-effectiveness	●	●	●	●	●			●	6
Learner-centered	●	●	●				●	●	5
Archival capability for knowledge reuse and sharing		●	●		●		●		4
Convenience				●	●			●	3
Dynamic (content updated easily / rapidly)	●				●			●	3
Learning/understanding (increased & comprehensive)		●		●				●	3
Personalization	●	●						●	3
(Fosters) self-paced learning		●	●					●	3
Different learning styles		●						●	2
Interaction (fosters interaction among students and instructors)				●				●	2

Advantages of e-learning	Roffe (2002)	Wang (2003)	Zhang et al. (2004)	Mitchell & Honore (2007)	Chen (2008)	McKenzie & Murray (2010)	Huang et al.(2011)	Mohammadi et al. (2011)	Total
Interactivity	●	●							2
Just-in-time / fast	●							●	2
(Develops) knowledge of the internet		●						●	2
Motivation (increased)		●						●	2
Potentially available to global audience			●		●				2
Retention (higher retention / recall of information)		●		●					2
Uniformity of content	●	●							2
Anonymity						●			1
Contemporary	●								1
Measurement of program performance	●								1
Opportunity to learn more than one major or specialty								●	1
Provide opportunities for more introverted student to engage more in learning						●			1
Responsibility (encourages students to take responsibility)		●							1
Scalable structure	●								1
Seat time (reduced seat time /contact hours)				●					1
Unlimited access to knowledge			●						1

3. Industry Standard: Levels of E-Learning

Not all e-learning is the same not even all asynchronous or synchronous e-learning is identical in effectiveness. To address this industry has widely adopted a model that breaks e-learning into four levels of learning interaction, from the most passive to most interactive (Omer, 2018). The first of these levels is passive e-learning with no interactivities. This level is most closely associated with the traditional method of sitting and listening to a lecture with no interaction or questions. It is one-way communication meant only for consumption. Largely, industry considers this format to not be an effective method of training. Despite this, 49% of e-learning courses developed still only reach this first level of interaction (Omer, 2018). The second level of interaction is limited interactivities, which can consist of instructor-proposed questions to check for comprehension. Most of the time, this manifests in the e-learning process by simple quizzes or knowledge checks and is slightly more effective at reinforcing knowledge transfer to students. The third level of interactivity includes more complex interactivities, such as rich audio and visual elements, customized visualizations, interactive quizzes and even games. Experts consider this the minimum requirement for teaching a new software application through simulation (Omer, 2018). Industry experts believe it is a more effective method to return capabilities instead of basic knowledge from the lower levels. The final level is a highly simulated environment that contains high-end graphics, virtual reality, and 3D simulations. This is the most expensive level of interaction and while effective at accomplishing learning objectives, the creator must be careful to not overdesign the learning compared to the desired learning goals (Omer, 2018). An example of overdesign is the creation of a multi-million-dollar video game to teach skills only moderately desired for a company's learning objectives. This is an important consideration for data literacy through e-learning efforts since varying archetypes and positions demand varying levels of skills. The industry has found that increased proficiency arises from increased interaction, and the AI archetype or Gold Standard proficiency level's requirements demand increased mastery with positional progression. This indicates that the level of interaction should increase as the level of mastery required for each contracting position increases.

4. Studies on E-Learning Efficacy in Adults

Understanding the types and efficacies of different e-learning is important, but equally important is understanding the efficacy of e-learning for adults when compared to traditional in person training. One very robust study conducted on Washington state community and technical college students examines the performance gap between students who took eLearning courses and those who took traditional face-to-face courses (Xu, 2014). Looking at 500,000 courses taken by 40,000 students, the researcher was able to identify an overall negative relationship between the course persistence and final course grade for online learners. Course persistence is "the intention to complete an online course in which the student is enrolled" (Lakhal et al., 2021, p. 4). This study found that a typical student has more difficulty succeeding in online classes compared to their more traditional course structure. I must note some other considerations here. The author found that some types of students are more likely to be successful in online learning. These students had advanced skills in self-regulation, self-discipline, and other associated metacognitive skills. Students can develop these skills through additional support if they are not inherent to the population. One method of incorporating the acquisition of self-regulation skills is scaffolding. Scaffolding describes a variety of instructional methods used to progress students toward higher levels of understanding and independence during the learning process. This study was not able to address the levels of interactivity within each course to draw meaningful comparisons between the industry four level model and the study results. It does however provide quantitative data showing that e-learning is an effective method of delivering training, though less effective than the traditional model, and is a possible method for delivery of data literacy training for contracting professionals.

Another 2018 study conducted by a team from the Southern Federal University in Russia, attempted to look at not just the efficacy of e-learning, but also its efficacy for a specific age group of adult learners (Olga et al., 2019). Using a group of 158 subjects between the ages of 35 to 50, the study had 79 subjects assigned to an experimental group using e-learning training, and 78 assigned to the control group using traditional face-to-face training. Members of the experimental group received their e-learning in the form of computerized visualization and information in an interactive manner. Using the industry

standard, this training's category is synchronous e-learning with level 2 interaction. The study found that there was a significant improvement in the objective skills developed by the experimental group, indicating e-learning was an effective method of delivering training to this demographic. Interestingly the control group did not show any significant improvement in learning objectives. Ultimately this study shows that e-learning can be effective for students at any age, and with varying levels of initial skills. It also allows for the students to customize their experience based on their individual characteristics and desired outcomes. This study's focus on older learners is critical for understanding the efficacy of e-learning even in our older, less recently in traditional school, workforce. Its findings that varying levels of skills can still find success in a customizable e-learning approach can support the use of e-learning as a training method for the USAF contracting workforce. Timing research has already indicated that any data literacy training program must consider the varying roles, responsibilities, and skill requirements of USAF contracting professionals.

Related to e-learning, there is a concern for individual instructional factors effect on a learner's outcome with this method of delivery. A 2009 study attempted to address this concern by distributing 75 questionnaires to determine whether individual factors (such as age, gender, education level etc.) or instructional factors (such as effectiveness of specific tools used, interactions with professors, or ease of use of technology use) are critical to retention through e-learning. Surprisingly, using Bloom's Taxonomy as the measure of success and regression analysis, they were able to determine that these factors did not play a major role in the learning process (Halawi et al., 2009). I used this study to inform any decisions that must be made about whether there is a clear need for customized programs for differing demographics or learning styles.

5. Emerging E-Learning Methods

New technology is making the e-learning sector expand outside of the typical e-learning formats. One delivery method that is emerging is digital game-based learning, specifically mobile learning games (MLGs) (Wardaszko & Podgórski, 2017). These are educational games created to be played on a mobile device, such as a smart phone or tablet.

Because of the new nature and rapid growth of this genre, the effectiveness of this method has not been studied extensively. However, one team from Kozminski University in Poland conducted a comparative study on 160 college freshman students. This team taught subgroups of students either by traditional textbook-based learning or using MLGs. Using a pre-test and two post-tests after three weeks of learning, the authors found that MLGs groups had positive learning outcomes at least equal to those of the control textbook-learning groups (Wardaszko & Podgórski, 2017). This would indicate that the USAF could potentially use MLGs as a viable equivalent answer to in-person data literacy training efforts.

A BYU graduate student fielded a similar type of study using an MLG but focused specifically on microlearning outcomes. Microlearning is "a new instructional design approach that delivers training in a short format—usually under fifteen minutes long" (Zhang, 2020, p. 3). It varies from typical e-learning/MLGs in its conciseness of content. This experiment fielded three prototypes for three kinds of learners with 30 mini-lessons containing data analysis learning objectives (Zhang, 2020). While the work was not completely conclusive due to the need to field multiple prototypes with varying degrees of success, the researcher found some key takeaways for teaching data analysis through microlearning sessions (Zhang, 2020):

1. Avoid using jargon in learning material
2. Use a knowledge test function to avoid requiring knowledgeable members from having to retake skills already acquired
3. Take work experience into consideration for specific types of data
4. Be consistent in visual design
5. Ensure bite-sized lessons to allow for flexibility in schedule of members
6. Provide additional resources for those interested in furthering education on their own

While this somewhat incomplete study does not tell me the exact resulting improvement or lack of improvement in learning outcomes, the lessons learned can

certainly be taken into consideration if the USAF chooses to pursue a micro-learning strategy the way the Defense Acquisition University (DAU) team is considering.

Please note: A more thorough review of different commercially available data literacy resources and available methods will follow in the Results: Executive Education section.

E. METRICS OF SUCCESS

Metrics of success in data literacy training and education used in industry, government or academic institutions is my final research question focus area. This is by far the least robust research area, and as I found it the hardest for current USAF contracting efforts or members to quantify. Industry standards for data literacy metrics are far from solidified; in fact, a Massachusetts Institute of Technology (MIT) Sloan study found that only one in five organizations even takes a formalized approach to ensuring data quality, to include data literacy efforts (MIT, 2019). Academia has also failed to establish solid metrics for data literacy; however, there is an understanding that higher education institutions have a need to create a learning experience that caters to the audience's current stages, with progressive improvements (Wong, 2010). In terms of government set data literacy metrics, currently the U.S. government workforce does not have metrics established. Canada, however, has made some headway in this area. Canada's national statistical agency, Statistics Canada, conducted an analytical study highlighting various methods taken by industry and governments to measure data literacy, mostly through the use of commercially available tools. These tools are divided into two categories for both individual data literacy and organizational data literacy metrics, self-assessment (subjective) measures and objective measures (Bonikowska et al., 2019).

1. Objective Measures for Data Literacy

Statistics Canada found only two objective measurement tools for measuring data literacy, and they were only for individual, not organizational, assessment (Bonikowska et al., 2019). The first tool, from the U.S. Department of Education, was a study conducted to assess the data literacy of teachers in the United States. The evaluators gave the teachers scenarios about students and data in the form of a table or graph. The teachers took the data

provided to them and found data backed answers, that included basic calculation requirements. The evaluators then recorded and analyzed these responses. The second tool was from a non-profit organization WestEd. The developers of this tool constructed four scenario-based assessments around a set of knowledge, skills and dispositions that the organization believes are necessary to use data effectively (Mandinach, n.d). These scenarios provide context, data, and ancillary information to allow teachers to showcase their data literacy skills. Unfortunately, neither details of what the knowledge, skills and dispositions are, nor any results have been published yet. Even without these results, the common connection between the two tools appears to be a scenario-based assessment that has a supervising party assessing the results of the decisions and products delivered to determine data literacy levels. This requires a high level of time investment as well as an existing cadre of data literate workforce members to assess developing member's skills.

2. Subjective Measures for Data Literacy

Statistics Canada assessed the following commercial off-the-shelf (COTS) subjective measurement tools Statistics Canada assessed are; Databilities, Qlik, Office of the Maricopa County School Superintendent Survey, and ODI's skills surveys. These all rely on some form of self-assessment (Bonikowska et al. 2019). Unfortunately, self-assessment, while a readily available tool, can be an unreliable metric of actual performance. One study conducted by Yale University and New Hampshire University on emotional intelligence found that "self-reporting and ability scales are only modestly correlated because people are notoriously bad at assessing their own capabilities" (Brackett & Mayer, 2003, p. 1155). This would indicate that self-assessment tools are not ideal for establishing metrics for USAF contracting professional's data literacy. It would be better to set objective measures tied to specific work requirements that are then tied to employer expectations.

One metric researchers of government data literacy agree on is that the DOD needs to "start with data" and that metrics for measuring success in the realm must develop over time (Kreb, 2020). USAF contracting has taken a step in this direction, by establishing specific types of data skills and expected mastery levels required from contracting

professionals in its Gold Standard. This could be the first step in setting objective requirements and expectations for employee performance, if implemented and enforced properly.

3. Other Data Literacy Related U.S. Government Programs and Studies

Recently published data strategies are not the first instances of the federal government attempting to address shortages of data literacy related skills in its workforce. In recent years, the federal government and its agencies have implemented various programs and conducted studies related to the acquisition and usage of data literacy skills.

a. Federal Government Data Literacy Related Programs

In 2019, the Office of Management and Budget (OMB) launched the pilot program Federal Cyber Reskilling Academy (FCRA) to reskill traditional federal employees for cybersecurity roles (Barrett, 2021). This program took 25 federal workers who were not in the field of IT and gave them 13 weeks of training in cybersecurity essentials in a hybrid format. The students began with a workshop, followed by four weeks of asynchronous e-learning exercises and exams, and a six day "boot camp." The students completed the course with two weeks of self-study and a certification exam. This program showed great results, with all 25 students successfully completing certification. Unfortunately, the program had problems in application to the workforce, as certified workers were unable to attain positions that required these cybersecurity skills because of restriction in government pay scale regulations (Barrett, 2021).

In 2020, the OMB launched another data literacy related data science training program. This course took 60 federal employees from multiple government agencies and gives them targeted data science training in key focus areas such as, "Python and R languages, machine learning, design thinking, data mining, data visualization, statistics, and enhanced presentation skills" (Barrett, 2021, para. 14). The hybrid course takes students through 18 weeks of asynchronous e-learning, followed by 10 weeks of synchronous e-learning led by an instructor and completed with a capstone project that must be delivered to the student's agency leadership. The response from agencies'

leadership for this program have been exceptionally positive and the OMB is currently considering how to implement this training on a larger scale (Barrett, 2021).

b. Army Data Literacy Program

In 2021, the Army created an Army Data Literacy program to address deficits in data literacy related skills in their workforce. This program breaks the Army's 1.4 million service members into five groups based on their base level of data fluency and creates a customized data fluency curriculum for each group. The instruction cadre is expected to come from in-house skilled members, but the method of delivery has yet to be released (Barrett, 2021). There are not currently any results from these efforts available to analyze the success of this venture but monitoring the largest service's efforts would be wise for anyone interested in future service wide data literacy training implementation.

4. Existing Research on Data Literacy in DOD Acquisition

The RAND organization, in response to Congressional concerns, conducted a study to assess the DOD's use of data analytics and data management in acquisitions. It is important to note that this study only conducted research in the scope of data analytics (McKernan et al., 2020). While this does indeed have some overlap with my adopted data literacy's definition, and with the content of many existing data literacy curriculums, it is not identical. In this research they attempted to answer six questions posed by Congress:

1. To what extent have data analytics been implemented?
2. What potential to increase DOD Data Analytics capabilities to improve acquisition outcomes is there?
3. How much Research and Development (R&D) funding is there to develop and implement data analytic capabilities?
4. What are private-sector best practices that could minimize collection and delivery of data by, from, and to government organizations?
5. What steps are being taken to expose anonymized data to researchers and analysts?
6. Do training institutions include appropriate courses on data analytics and other methods and their applications to defense acquisitions? (McKernan et al., 2020, p. 5)

Of these questions, research results from questions 1,2,3, and 6 provide some DOD specific insight to inform my research questions. In the following section, I summarize the

general data literacy implications from each question's result as well as highlights any results that are specific to any of my research question themes: content, method, timing, or metrics.

(1) RAND's Research Question 1 Data Literacy Takeaways

RAND's team found that as of 2019, the DOD had spent an estimated $11-$15 billion a year on the workforce employed for their analytic skills as well as approximately $3 billion a year for IT systems for acquisition (McKernan et al.,2020). This indicates that the DOD currently has extensive access to data analysis resources. The team also determined that data management is required for successfully accomplishing data analysis and while the DOD did follow industry best practices for some data management fundamentals, the level of maturity exhibited varied extensively across the enterprise. Finally, the RAND team found that leadership was using data analytics for high-level decision making, but often failures resulted when decisionmakers made choices contrary to what the analysis suggested. They found these decisions to be due to non-data related factors such as political or mission impact concerns. Overall, this shows that DOD acquisition is a place where there is a high potential for contracting professionals to capitalize on available data infrastructure and increased data literacy to improve acquisition outcomes.

(2) RAND's Research Question 2 Data Literacy Takeaways

For the second question, the RAND team found that one major hurdle in data analysis adoption was related to the lack of access by analysts to analysis tools and data repositories (McKernan et al.,2020). They acknowledged that the DOD has made significant strides in this area, but noted that there is still potential for improvement. From a cybersecurity perspective, possible improvements include increased testing and creation of a DOD wide list of approved analysis tools and expanded use of virtual desktop environments. For data access, they recommend making significant improvements to give access to data to both external and internal government analysts. This means the DOD must streamline permission requests and educate data owners on the benefits to interagency data sharing. Finally, they suggest that there be changes made to the incentives systems for

decisionmakers, to encourage them to become more capable of data analysis comprehension. Specifically, for those leaders that the DOD raises through the ranks, it suggests that there be career long training for understanding the strengths and limitations of data analytics. This is directly related to my research question themes of content and timing. For content, the RAND report addresses the need for data focused training. For timing, it proposes a continuous learning process timed throughout a contracting professional's career to ensure that they can make decisions from a data literate platform.

(3) RAND's Research Question 3 Data Literacy Takeaways

In response to the third question, the team estimates that the DOD currently has $200 million for R&D funds related to general data analytics capabilities and about $520 million a year for IT systems specific data analytics capabilities (McKernan et al.,2020). This is an 80% and 40% increase from the previous year's spending. This shows not only an increasing emphasis on data analytics but also a desire to innovate in the field. This is encouraging for work in the data literacy field since data analytics capabilities are a common theme of many data literacy definitions.

(4) RAND's Research Question 6 Data Literacy Takeaways

The final question is also the most applicable to my specific research questions and contain the most insights into my research question themes. The RAND team found that existing DOD institutions do provide appropriate training opportunities for data analytics (McKernan et al.,2020). The method of delivery of this training is varied. DAU and the Air Force Institute of Technology (AFIT) offer both asynchronous e-learning and traditional in-person training while the Naval Postgraduate School (NPS) and National Defense University (NDU) provide traditional in-person training options. In addition to these traditional training programs, they also emphasized the need for on-the-job training (OJT) and the use of existing tutorials and resources as methods of training delivery. The last method related recommendation was the finding that to improve dispersal of data analysis skills throughout the DOD workforce, employees should rotate through offices that have a high data-analysis workload. This will lead to increased awareness of availability and benefits of analytics-based courses and encourage members to expand their analysis skill

sets by building a data focused culture. It is important to note the data limitation here. The team did not investigate how effective these courses were, only that they existed.

Timing-related results from this research question found that while these courses are useful, it is necessary to scale skills acquisition to the needs of a position. Not every member of the workforce needs to become a data scientist. A data literacy program's training events should provide needed skills based on an employee's position, not simply time in service or pay grade.

This directly informs my research as I look at several of these available courses in my quantitative analysis section. It also provides expert support for the idea that data literacy training cannot simply be available for use at will. We must actively incorporate it and encourage its development in the progression framework for a contracting career to ensure its ultimate success.

III. METHODOLOGY

This section investigates both the current state of USAF contracting data literacy and how commercially available data literacy enabling programs might tie into any recommendation resulting from this research. This research utilizes semi-structured interviews with two key groups within USAF contracting; members of the USAF's Contracting Business System (SAF/AQCI) Data Literacy Program and members of the data literate focused USAF team Kessel Run. I formulated questions for each group focused on determining how their organizations defined and cultivated data literacy. In addition to the one-on-one interviews, I also held three focus groups speaking with groups of three to four USAF Contracting Officers attending NPS. These members were also given questions meant to ascertain the level of awareness of agency wide data literacy efforts, uncover trainings that may have been conducted in a less agency wide approach, as well as to gauge the general awareness of the basics of data literacy in the business sector. The focus groups were also given a post-focus group questionnaire to determine what impressions participants had about data literacy and the technical skills related to it. All groups did not receive identical questions nor did every group have questions regarding my four key sections: content, timing, methods, and metrics. The questions could not be identical, because each group had its own expertise and mission focus. However, all questions were meant to capitalize on the unique experiences and efforts within each organization to help inform my final data literacy training roadmap recommendation. The final method I use is quantitative and qualitative analysis of 47 existing commercial programs that train some element of data literacy at varying skill levels. These are not all-encompassing data literacy programs, but rather they train one or more data literacy related component. This list was based off existing research in executive education as well as programs of interest that came up throughout my research.

A. DATA COLLECTION

I conducted four one-on-one semi-structured interviews over the course of three weeks with key participants in the USAF's Contracting Business System (SAF/AQCI)

Data Literacy Program. These interviews were to discern the extent of current data literacy efforts undertaken by USAF contracting to avoid duplication and to understand current mission objectives and curriculum content. I intended these questions to find any current data literacy content, method, timing, and metrics that were currently in use and to identify gaps where my research could add value.

Next, I contacted Kessel Run. Kessel Run is a USAF software organization based in Boston, MA, whose mission is to "deliver combat capabilities warfighters love and revolutionize the Air Force software acquisition process" (Kessel Run, n.d., para. 1). Over the course of four weeks, I questioned five members of this team from various career fields and levels of responsibility, to ascertain how this team was able to create a culture of data literacy within its ranks. I asked targeted questions about what type of training content they had received and what methods of delivery of this training were made available to them. Finally, I tried to determine if there were any other unique characteristic that were embodied in this organization that made it successful at creating a data literate workforce. This unique characteristic could be something like a culture of innovation, or a unique mix of military and civilian personnel.

For the final group of nine interviews I conducted three focus group sessions with three participants each. These interviewees were all USAF contracting professionals attending the NPS's Acquisition and Contract Management, Master's in Business Administration program. None of these members have had any formal data literacy training provided to them by the USAF. I selected these members through a convenience sampling from a pool of 30 students in the 2021 and 2022 cohort. I created questions to determine what the general awareness level for both SAF/ACQI's data literacy campaign and the DOD's AI education requirements are, what various USAF contracting organizations may have done for training in a decentralized way, and what data literacy skills participants' previous organizations have found valuable in its members.

The last collection of data expanded on previous research into executive education programs for the USAF conducted by Major Daniel Finkenstadt. I filtered this collection of programs down to include only programs that are related to data literacy, and I supplemented it with programs of interest that emerged during my research. This resulted

in the summarization of 47 programs with five components of data pulled from each. These components are length of course (in days), price, method of delivery, course description and content, and target audience. The component for method of delivery breaks down further into three categories: in-person, online (asynchronous) and online (synchronous). The component for target audience is refined into three categories: entry-level, mid-level, and senior-level, with many of the programs targeting multiple target audience categories.

1. Participant Selection

One challenge in addressing the state of data literacy within USAF contracting is that newness of the concept and its emerging nature within the industry and academia makes the pool of potential USAF expert interviewees quite small. I have attempted to address this by either exhausting participation willingness from an organization, interviewing every member of a very small organization, or receiving redundant responses to such a level that I felt confident I could gather no further insights from a larger cross section. In total across the three organizations, I conducted 18 open ended interviews.

a. Data Literacy Leaders

Preliminary subject matter research identified the Data Literacy Campaign team as the current leaders in data literacy content creation for the USAF contracting career field. Their position working with Contracting Business Systems, the organization that oversees creating and maintaining business solutions made them key initial interview subjects. This office is responsible for business solutions such as CON-IT, which is the USAF's primary contract writing system and Project Management Resource Tools (PMRT), which is the USAF site containing core acquisition tools and information for a range of acquisition communities. The four members who I interviewed make up a very small team of contractors and civilian employees, all of whom have other responsibilities beyond the data literacy campaign but participate as either an additional duty or on a volunteer basis. I conducted all interviews via Microsoft TEAMS and recorded and transcribed them for later analysis.

b. Data Literate Air Force Team

I selected members of the Kessel Run team through a call for volunteers willing to speak about data literacy. I interviewed five employees who were able to provide insights. I was not able to reach the point of redundancy in responses (i.e., saturation) due to difficulty in contacting additional Kessel Run employees. This organization can be hard to contact given their operational tempo and non-traditional structure. However, the data they provided is still valuable in providing insights into what key things may be necessary for a successful USAF contracting data literacy training effort. They also provide a rich commentary on learning from missteps and challenges they encountered. Again, I performed all interviews via Microsoft TEAMS video conference and recorded and transcribed them for further analysis and review.

c. Data Untrained Air Force Contracting Officers

I interviewed a convenience sample of members of the data untrained group from the NPS MBA cohorts. They were ideal because of their diverse organizational and contracting experience. These participants gave me a good preliminary idea of what the status of data literacy could be within the USAF commissioned officer contracting professionals. It is important to note that these members do not represent all contracting officer's experience, neither do they account for the experience of enlisted contracting professionals. It simply provides a limited case study to show the experience of a range of contracting professionals and gives an idea of some general areas of possible focus or improvement for the proposed road map.

2. Participant Demographics

Figure 8 shows that of the 18 interviewees four had less than 5 years of experience in the USAF, seven had 5–10 years of experience, two had 10–15 years of experience, three had 15–20 years of experience and two had more than 20 years of experience working with the USAF.

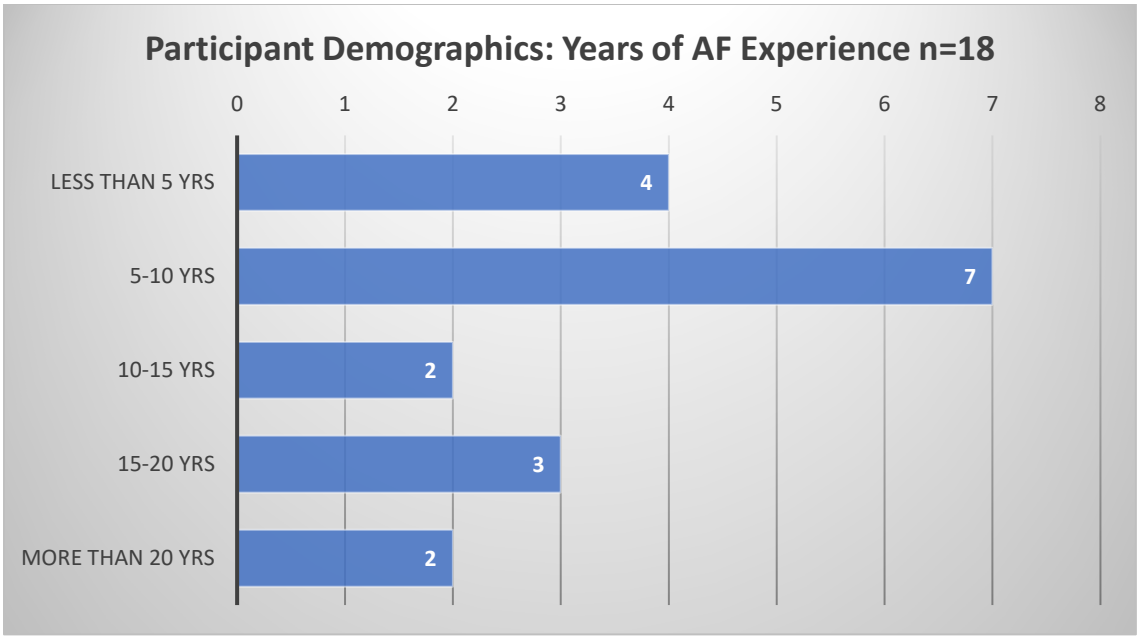

Figure 8. Demographic Data: Years of Experience in Air Force

Figure 9 shows that of the 18 interviewees one had no experience in government contracting, six have less than 5 years of experience working in contracting, six had 5–10 years of experience, two have 10–15 years of experience, one had 15–20 years of experience and two had more than 20 years of experience working with government contracting.

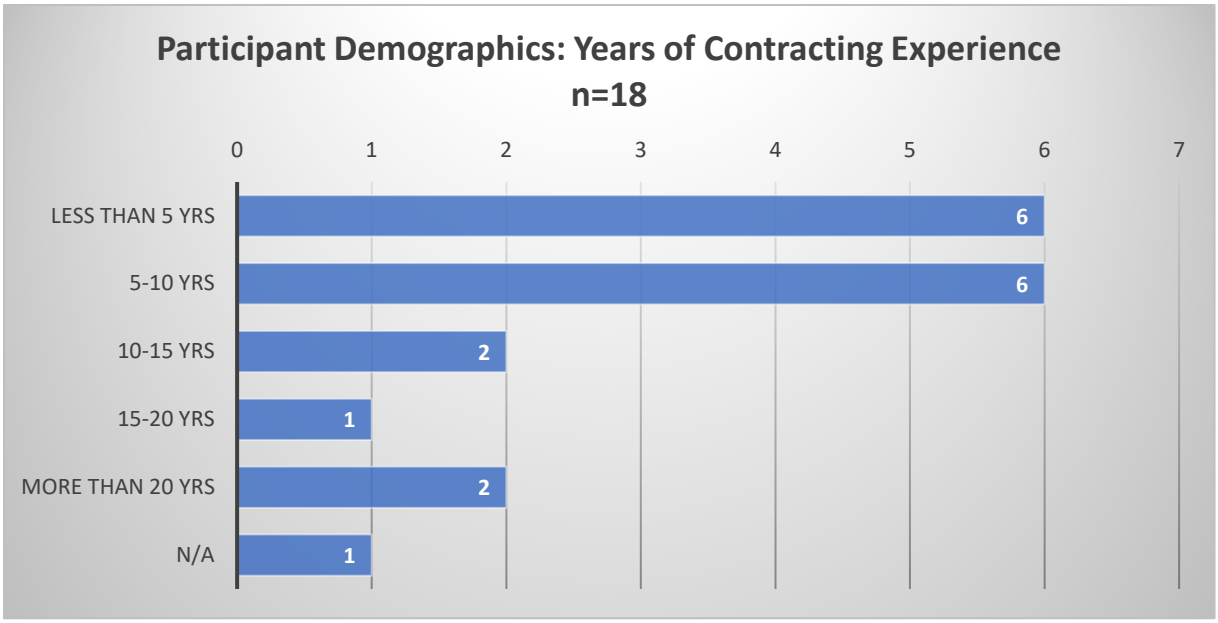

Figure 9. Demographic Data: Years of Experience in Contracting

Figure 10 shows that of the 18 interviewees 9 were female and 9 were male.

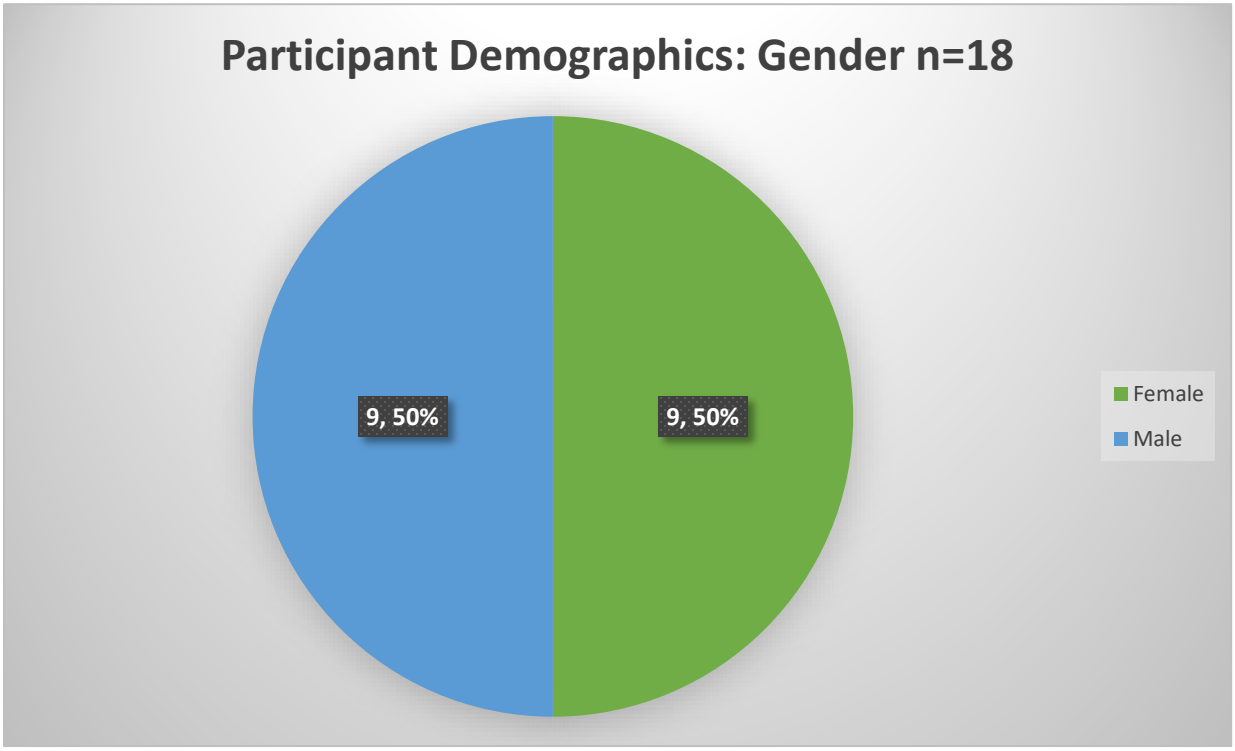

Figure 10. Demographic Data: Gender

Figure 11 shows that of the 18 interviewees, 12 were active-duty military members, four were USAF government civilian employees, and two were USAF Contractors.

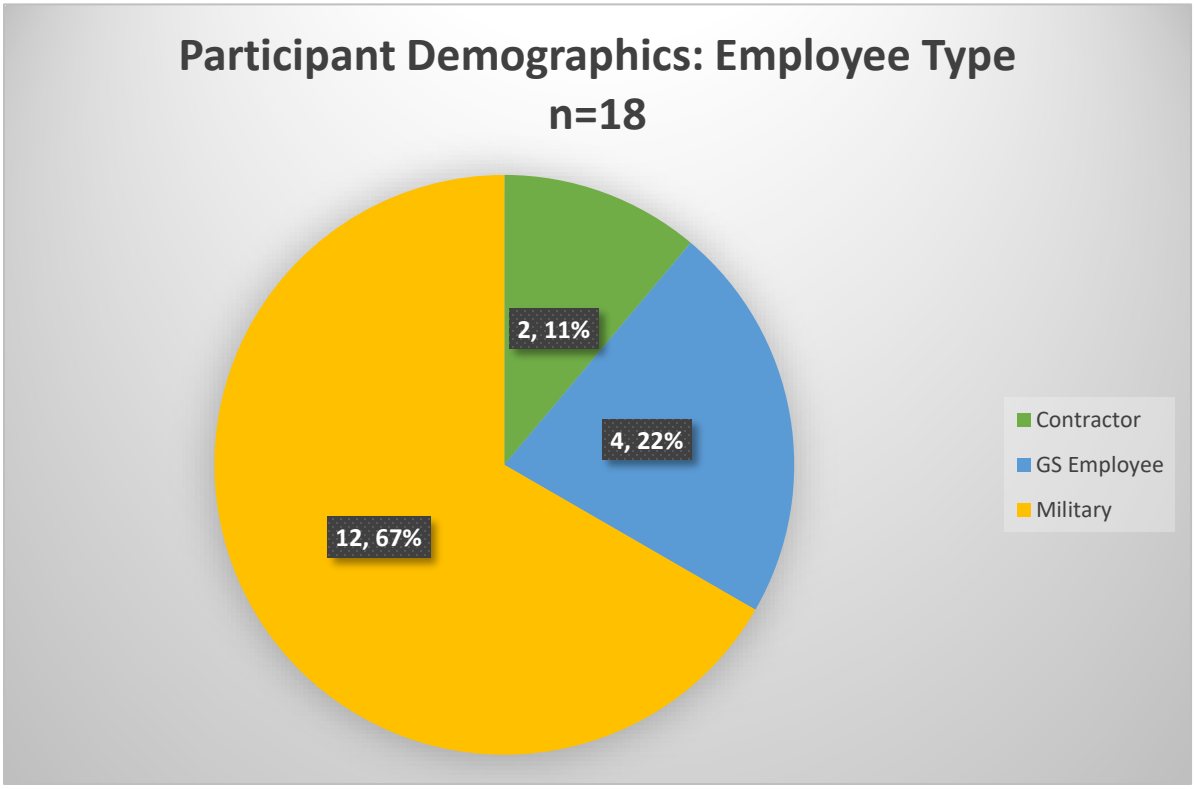

Figure 11. Demographic Data: Civilian/Military

Figure 12 shows that of the 18 interviewees, three were USAF contracting civilians (1102), nine were USAF military contracting officers (64P), three were USAF military acquisition officers (63A), two were contracted support, and three were other government civilian support and one was other.

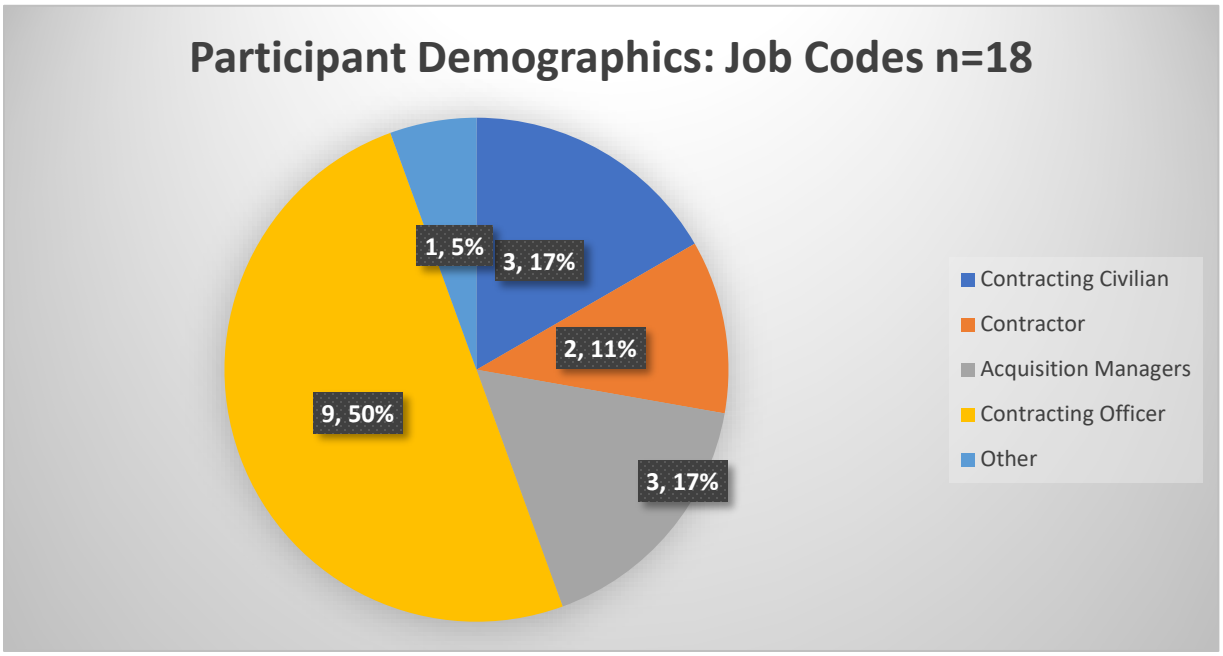

Figure 12. Demographic Data: Job Code

Figure 13 shows the data literacy groups each interviewee belongs to, and Table 8 provides a defining characteristic of those groups. Figure 13 shows that of the 18 interviewees, nine are data untrained, four are data leaders, and five are data literate.

Additionally, the data analysis section has demographic information in support of qualitative analysis conclusions.

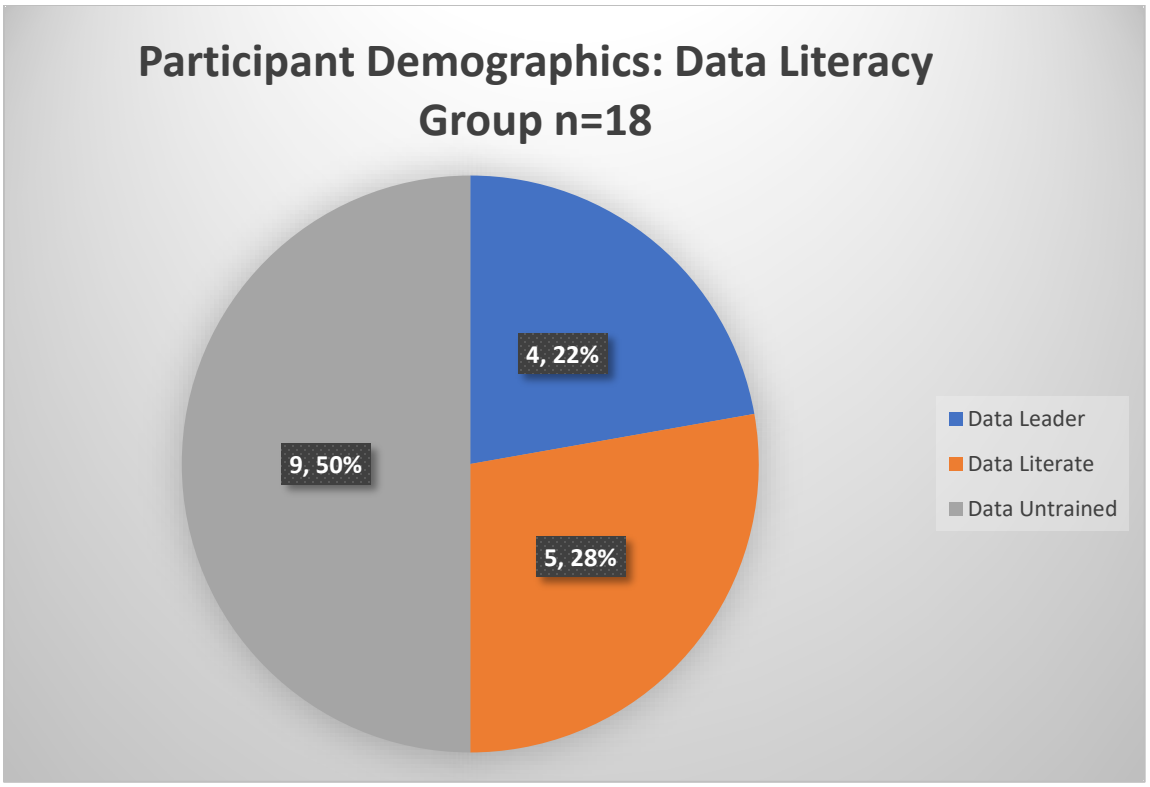

Figure 13. Demographic Data: Data Literacy Group

Table 8. Data Literacy Group Definitions

Group Name	Definition
Data Leader	Member who has been identified in USAF contracting as being responsible for data literacy curriculum development and implementation.
Data Literate	Member who has received training in data literacy content and application in the context of this study, these are members of the Kessel Run team.
Data Untrained	Member who has received no official USAF training in data literacy content.

B. DATA ANALYSIS

1. Qualitative Analysis Methodology: Understanding Thematic Coding

The methodology for qualitative analysis for most of this research is done using thematic coding. Thematic coding is a "systematic process to organize and highlight meaning" (Vaughn & Turner, 2015, p.1.). This methodology is the dominant process employed by researchers utilizing qualitative data, because of the inherent challenges faced in this type of analysis, especially using interpretation appropriately and maintaining consistency of interpretation of data. This process consists of the researcher reviewing qualitative data, in my case interview question responses, and highlighting key concepts that arise in each response. After each response has had an initial review, the researcher must begin grouping and consolidating responses that are related or synonymous. After this is done, the researcher can take these keywords to identify themes that answer research questions or provide insight. This is a very labor-intensive process and involves human interpretation and judgement. While recent technological innovation has allowed for some of this type of analysis to be done using software options, because of my smaller sample and selection of data points I was able to do this manually using Excel as an organizational and analytic software.

2. Description of Interview Qualitative Analysis of Themes

I created transcripts of each interview I conducted. I used notes taken during the live interviews and recorded additional impressions that emerged when re-watching recorded interviews. This allowed me to ensure that I was able to take nonverbal cues into consideration for areas of special interest to the interviewee, as well as fill in gaps in my initial notes caused by note taking limitations. In total I reviewed 94 pages of transcripts from 390 minutes of interviews.

After transcription, I created a database in which each question asked had a unique workbook where I recorded every participant's answer to each question. This allowed me to be able to read all responses to each question on a single document. Using the thematic coding methodology, I reviewed each interviewee's responses and highlighted keywords or concepts from their answer. After my first review, I used my best judgement and

interpretation to identify keywords that emerged from each response and consolidate synonymous answers. This allowed me to identify repeat concepts and keywords that arose from each question.

My next step required grouping the questions from all the three interviewee experience groups: data untrained, data literate, and data literacy leaders. I assigned these questions to either one of the four-research question focus themes: content, timing, method, and metrics. Three questions' answers provided insights into more than one of these research question categories. Regrouping these questions into research question themes enabled a more in-depth analysis across all interview experience groups. It is important to note that the interview qualitative analysis did not reveal any insights into the timing research category bin.

I then analyzed each group of research question themes for possible subcategory themes that may have emerged based on the interviewees' answers. For example, after reviewing all content related questions and answers, I found that there were subcategories relating to current offerings for content, desired skills/content for future content, definition of data literacy content, as well as the potential sources for future content providers. Methods had two subcategories: current methods and desired methods. Timing and metrics had no subcategories, and other had four subcategories: lessons learned, exemplars, awareness, and suggestions.

Finally, I consolidated the keywords that emerged from each of these categories into lists that identified the keyword/concept in one column and the number of occurrences of that keyword/concept from the interviewees' responses. For example, Table 9, shows the top three most common keyword/concepts from all interview questions related to content from the interviewee responses.

Table 9. Example of Keyword Summary Tables for Qualitative Data

Count	Keyword
16	CON-IT skills
13	Excel skills
13	Other Contracting Support Database Skills

3. Description of Thematic Coding Qualitative Analysis Validation Process

To validate my qualitative interpretation of the data, after compilation, I found the keywords that represented a minimum of 2% of the observations from each research category bin. This resulted in 7–9 terms each and extracted the word or phrase from each research question theme. Unfortunately, due to the lack of qualitative data from interviews on timing, I was only able to extract keywords for content, methods, and metrics. I randomized the ordering of these questions and asked a test functional expert to take the words and place them into the bin they found it most strongly associated with. I also provided them with the definitions found on Table 1 for my research category bins, as well as some clarification on what some more obscure programs or concepts were. After this tester provided their response and feedback, I evaluated the wording of the keywords to ensure that they properly conveyed the topic clearly by themselves. I changed some confusing wording from vague words to more specific words, such as "awareness" to "program awareness" and "Excel" to "Excel skills." I provided these adjusted terms and definition table to a panel of four functional contracting experts asked to repeat the binning process to further validate my own thematic binning prior to further analysis.

4. Description of Qualitative Analysis for Executive Education Programs

I used the same thematic coding method used in the interview analysis to summarize the component of the executive education data that had a qualitative nature, course description. The information for this section was directly extracted from the course's description and the analysis of this data was not as subjective as the analysis for interview responses. I conducted two reviews of this information. For the first review, I

extracted listed curriculum content from the course description and objectives. The second review, I consolidated these keywords as consistently as possible by grouping like concepts and synonyms. I then used the same keyword count method from the interview analysis to find the most common terms or phrases that occurred throughout the 47 programs. This allowed the quick review of content level one might expect from a commercial data literacy program.

Additionally, using these keywords, I was able to use the quantitative component, target audience, to create a summary of what content is prevalent in commercial programs for each level of career progression. This is helpful for understanding potential industry timing expectations for obtaining different types of data literacy skills (content).

5. Description of Quantitative Analysis for Executive Education Programs

To analyze the quantitative components of the executive education data I performed both summary statistics and regression analysis on the data. First, I broke the programs into the three methods of delivery, in-person, asynchronous e-learning, and synchronous e-learning to ensure the clearest results. Then using Excel's summary statistics data analysis function, I found the summary statistics for each method of delivery. Next, I used the correlation function to determine if there was a correlation between each method of delivery's price and length of course. I averaged these out and created a summary table to show what the correlation was, and what the average and median costs per day were as well.

6. Description of Qualitative Analysis from Literature Review Documents

While the interview data did not provide any insights into the timing research question theme, data from the literature review timing section can provide some insights. First, I summarized rank progression expectations, contracting milestones/ position expectations and whether the position is an entry, mid or senior level position from the contracting CFETPs. Then I incorporated the data literacy skills mastery levels required for each KSA found in the Gold Standard Narrative. Next, I aligned either the Employ AI

or Drive AI JAIC archetype to the contracting positional focus provided from the CFETPs. The infographic is based on the expectation of a career spanning 20 years before retirement (USAF, 2017). This provides a single comprehensive visual tool with which to provide suggestions for timing for data literacy training based on established expectations.

In addition to the compilation of timing data, I also performed thematic coding on the data collected from academic research on data literacy definitions and recommended data literacy content. I performed this analysis in the same manner as all other thematic coding, with summarization of like themes or topics, to provide the most digestible summary of academic recommendations.

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IV. RESULTS

A. METHODOLOGY VALIDATION: BINNING RESULTS

The summary results of my thematic coding validation process appear in Table 10. The grey column is my analysis of which theme I found each keyword to fall into. Green in the expert's column indicates that the respondent binned the keyword in the same theme as I did. When an expert included more than one category, if either category marked is correct, that cell is marked green. The percentage matched for each keyword is in the far-right column, highlighted using a red to green heat map.

Table 10. Methodology Validation Results

Keyword	My analysis	Expert #1	Expert #2	Expert #3	Expert #4	Keyword Match %
iteration comprehension	Metrics	Metrics	Content	No Answer	Metrics	50%
industry standard	Metrics	Content	Content	No Answer	Content /Metrics	25%
weekly spotlights	Metrics	Method	Method	Method/ Timeliness	Method	0%
leadership pipelines	Method	Content	Method	Content/ Method	Metrics	50%
product suite	Metrics	Content	Content	Content /Method	Method	0%
program awareness	Metrics	Metrics	Content	Content	Content	25%
Genius bar	Method	Method	Method	Method	Content	75%
Microsoft suites skills	Content	Content	Content	Content	Content	100%
founders goals	Metrics	Content	Content	Content	Metrics	25%
data tools selection/use	Content	Metrics	Content	Content/ Method	Method	50%
Unit experts	Method	Method	Method	No Answer	Method	75%
Excel Skills	Content	Content	Content	Content	Content	100%
OJT	Method	Method	Method	Method	Method	100%
Keyword	**My Analysis**	**Expert #1**	**Expert #2**	**Expert #3**	**Expert #4**	**Keyword Match %**

DAU courses/Modules	Method	Method	Method	Method	Method	100%
data analysis	Content	Content	Content	Content	Method	75%
Pivotal	Method	Content	Metrics	No Answer	Method	25%
contractor trainers	Method	Method	Method	Method	Method	100%
team effectiveness	Metrics	Metrics	Metrics	Content	Metrics	75%
communicate data as information	Content	Content	Content	Content/ Metrics	Content/ Metrics	100%
Other Contracting Support Database Skills	Content	Content	Content	Content	Content	100%
Digital DNA (Course)	Method	Method	Content	Content	Method	50%
agile software acquisition methodology	Content	Content	Method	Content/ Method	Method	50%
CON-IT Skills	Content	Content	Content	Content	Content	100%
Tableau Skills	Content	Content	Content	Content	Content	100%

Using the 50% or better statistic for each keyword, I validated all of my keyword's binning in the content and method categories, with the exception of the keyword Pivotal. This is understandable as none of my experts have worked in the Kessel Run organization, which is where that term came from. Because the validation percentage for Pivotal was below 50%, I removed it from the results figures and recommendations. All my keywords for the metrics bin were below a 50% agreement rate and could therefore not be validated. This finding is still informative to my research question, and I address the implications of this invalidation in the "Metrics: Interview Thematic Analysis" section.

B. INTERVIEW THEMATIC ANALYSIS RESULTS FOR DATA LITERACY CONTENT

Figures 14 shows the keyword count summaries all content interview question responses. Figures 14–17 show keyword count summaries for the subcategories as described in the "Description of Interview Qualitative Analysis of Themes" section.

This table as shows the content the all groups of USAF professionals interviewed most expected to see from the USAF contracting career force. The most frequently addressed content topic was "CON-IT" skills. CON-IT is an internet-based contract writing system that is the dominant contract writing system for the USAF. It interacts with various other government databases, such as Sam.gov and the Federal Procurement Data System-Next Generation (FPDS-NG), to write contracts and report contracting data to various federal databases. Multiple interviewees indicated that CON-IT training was one of the few types of formal data literacy type trainings provided to contracting professionals. The USAF gave many of the data untrained respondents some form of formalized training as well as provided resources to help navigate technical difficulties and reporting quirks.

The second most common content expectation was skills in using the Microsoft Office Suite tool "Excel." I did not find this response's frequency surprising, as all government computers have the Microsoft Office Suites available to them. This makes its data management product, Excel, something that most USAF employees are familiar with and use regularly. Interviewees recalled employees who had moderate to advanced Excel skills who built workflow management tools and templates for day to day contracting operations. Interviewed members considered these employees valuable as both trainers and problem solvers within the interviewees' organizations. It is also important to mention that the only two of the data untrained interviewees received any sort of data literacy related training. This training was for Microsoft Excel, and they received as a professional development opportunity from a previous USAF career field. This would indicate that both USAF contracting personnel and other career field leadership find significant value in these kinds of data literacy skills in the workforce.

The third most common content topic was "other contracting support and database skills." This is a compilation of all mentions of systems such as FPDS-NG, Electronic

Document Access (EDA) and the PMRT. These are all database tools used for reporting of contract actions, as well as tools used to create reports for leadership and market research purposes. All groups of USAF members found the skill to be able to utilize and navigate these tools as important for data literacy in USAF contracting. This proficiency requirement is also a key component of the Data Literacy Campaign initiative. This team of data leaders use venues such as BI Genius Bars (synchronous webinars) and one-page informative handouts to elevate the skills of contracting members for these business intelligence tools.

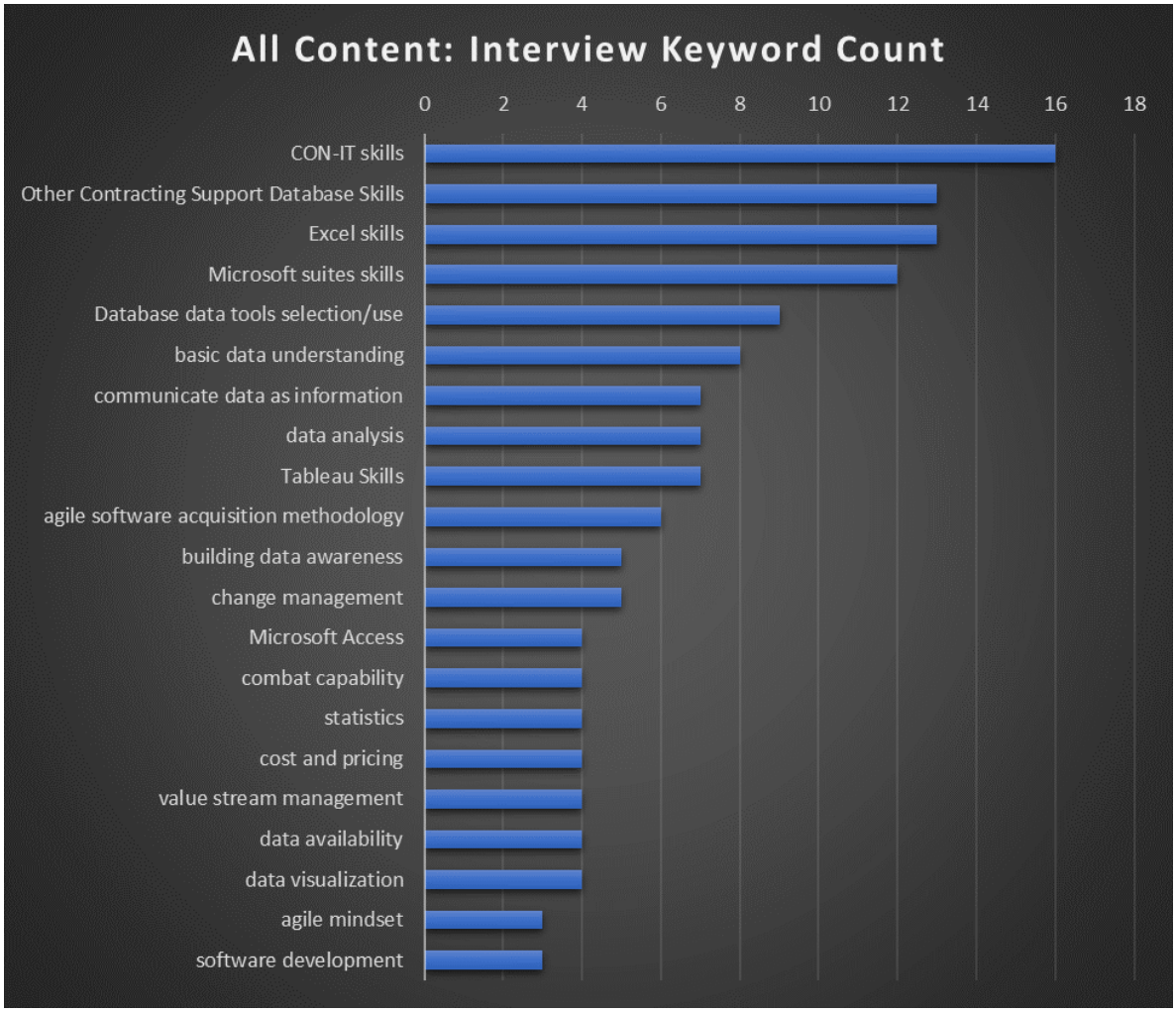


Figure 14. All Content: Interview Keyword Count

Figure 15 summarizes the top five most common themes from the subsection on data literacy definition from the interview data. It is important to note, that of the 18 interviewees eight of the data untrained group did not have any exposure to a definition for data literacy. Of the remaining ten participants, four data leaders, five data literate members, and one data untrained, seven believed that to be data literate, a member must at the minimum hold some "basic understanding" of how data works. This agrees with the definitions from experts as summarized in the data literacy definition literature review section of this paper. Understanding appears as the fourth most common theme for data literacy definition.

The second most common interview theme in the definition subsection is "training." This differs from the experts' definitions, as training does not appear in any of the expert's definitions. The definitions from experts tended focus on the types of skills that a person attains to become data literate, but all three groups of USAF professionals appear to take a more acquisition-based approach to the concept.

The third most frequent phrase to arise from our sample is "tools." This also does not appear in the expert's definition of data literacy. This is not necessarily a surprising finding however, as the USAF acquisition leadership has emphasized the development of business intelligence tools in recent years and has adopted the motto of "Tools Not Rules" (Powers, 2019).

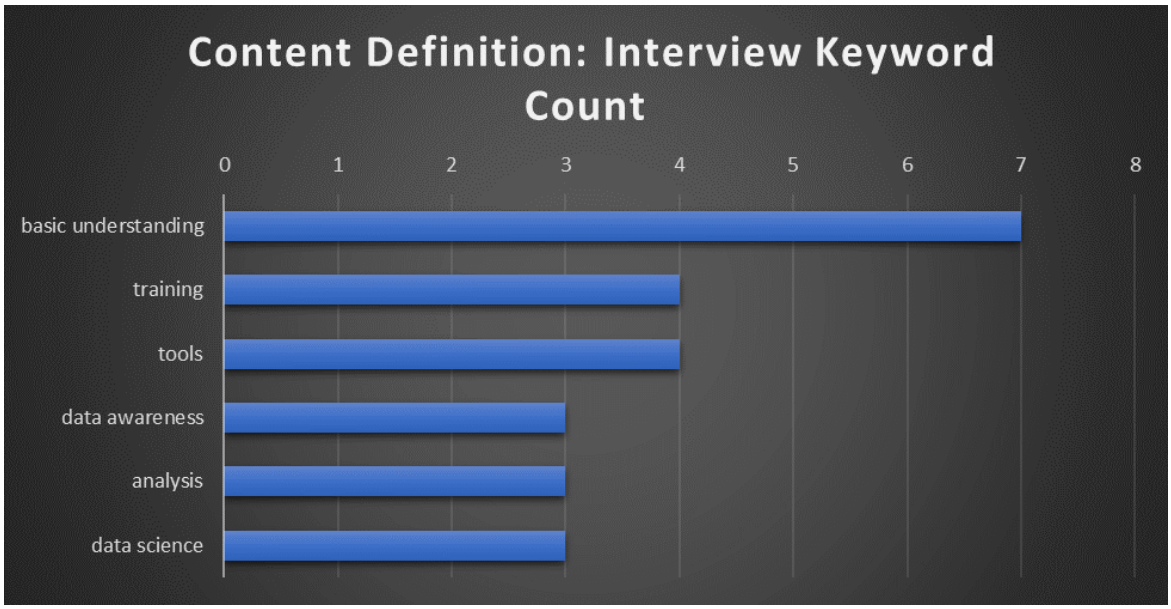


Figure 15. Content Definition: Interview Keyword Count

Figure 16 shows the summary of the desired skills subsection of the content theme. This is a critical section of data, as it tells us what a small sample of USAF members view as critical skills necessary to improve the data literacy and day to day operations of the USAF. The content summary section of the executive education data analysis will show us what industry or academia views as valuable, but this can provide insights directly from those working USAF contracting mission requirements.

I already summarized the top four most expressed desired skills in the "Top Three Content Analysis Results Insights" section and I found no analytic value in further delving into these as a subsection.

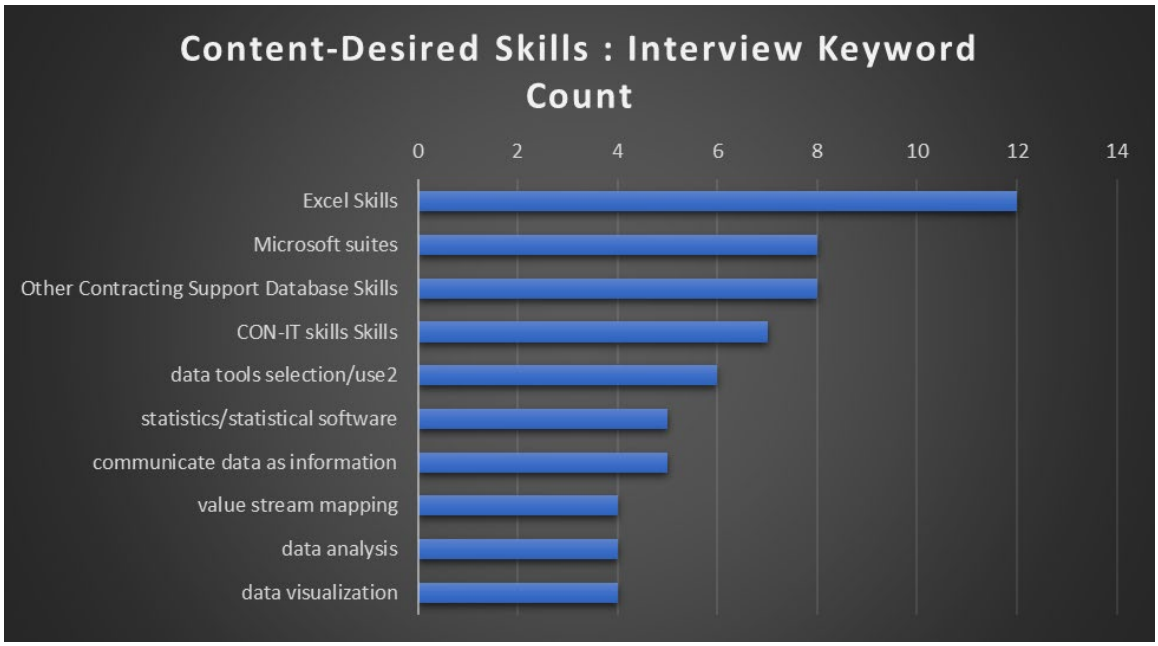


Figure 16. Content-Desired Skills: Interview Keyword Count

The final content subsection is current data literacy content offerings summarized in Figure 17. This section was a synopsis of questions related to what kind of content the interviewees knew to be currently available for their use. The most frequent keyword, "software development skills," appeared twice as many times as the next most common one. This is unsurprising as five of the interviewees were members of the Kessel Run organization which specializes in providing software to the warfighter. Outside of the mentions of these internal Kessel Run data literacy training opportunities, two members mentioned a relatively new program provided to acquisition professionals, Digital DNA. This course teaches acquisition professionals skills to understand how software development processes occur and to provide them insights for the acquisition of these types of services.

I have already addressed the second most frequent term, "CON-IT skills," in the "Top Three Content Analysis Results Insights" section. The third most common term is "data availability." This term was especially prevalent in the inputs from the Data Literacy Campaign team, who were making a concerted effort to try and ensure that contracting professionals had access to the data necessary to create business intelligence products.

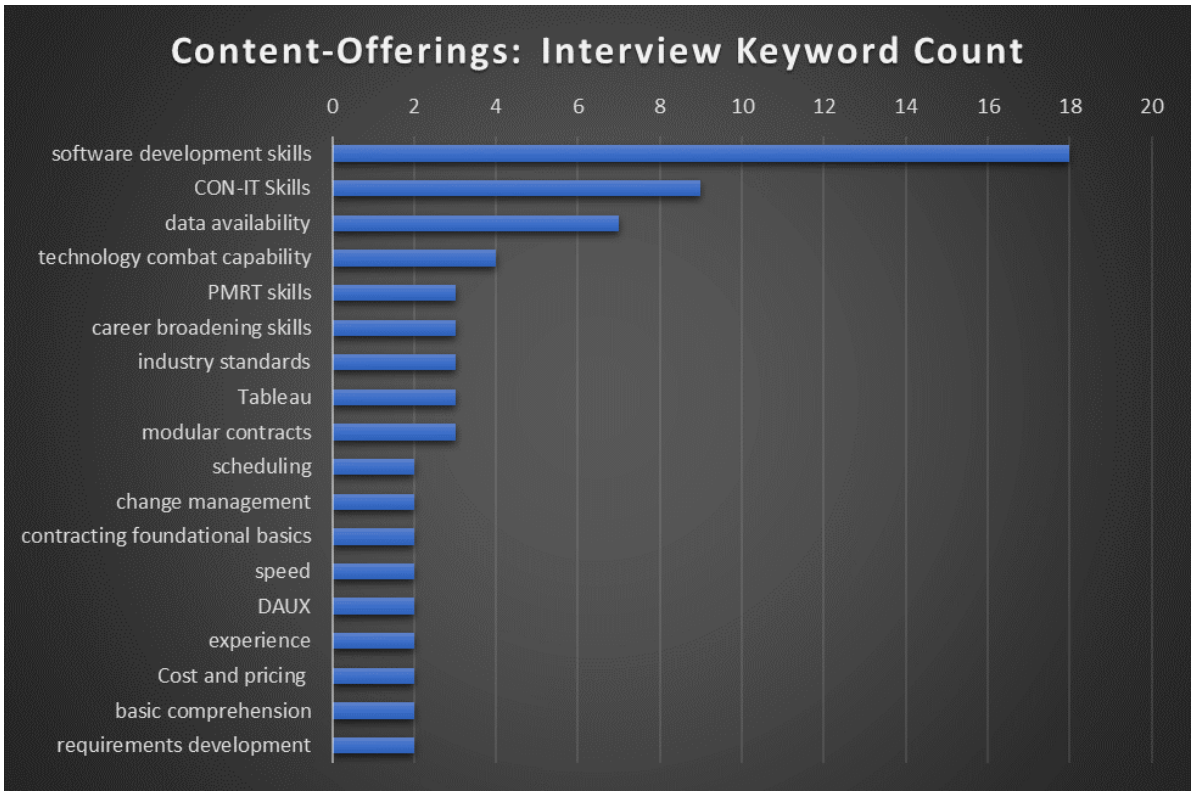


Figure 17. Content-Offerings: Interview Keyword Count

C. INTERVIEW THEMATIC ANALYSIS RESULTS FOR DATA LITERACY METHODS

Figure 18 summarizes the responses of all interviewees to questions related to the method of data literacy content delivery. The most dominant theme is "OJT," with 15 occurrences. This is telling of the dominant training method currently in place in USAF contracting. According to the CFETPs for both officers and enlisted, while the USAF sends members to official training events throughout their career progression, the level of competency required for qualification occurs from hands on, on the job training (USAF, 2017). This type of training is most closely linked with the traditional in-person method of training delivery.

The second most common phrase was "contractor trainers." This was dominantly the response from Kessel Run members because this organization is structured such that individual data expert contractors are hired to work alongside and train USAF personnel. Members lauded this format as innovative because it infused industry expertise into the

USAF workforce. This type of training would most closely be related to the traditional in-person method of training delivery.

The third most common terms for the method section were “leadership pipelines” and “unit experts.” As I addressed in the content section, organizations informally use unit experts to impart personally procured data literacy skills on the workforce. Interviewees viewed leadership pipelines as a conduit to provide opportunities for, and awareness of, various data literacy type educational opportunities. Unit experts are similar to contractor trainers in their in-person method of training while leadership pipelines do not specify one type of method over the other.

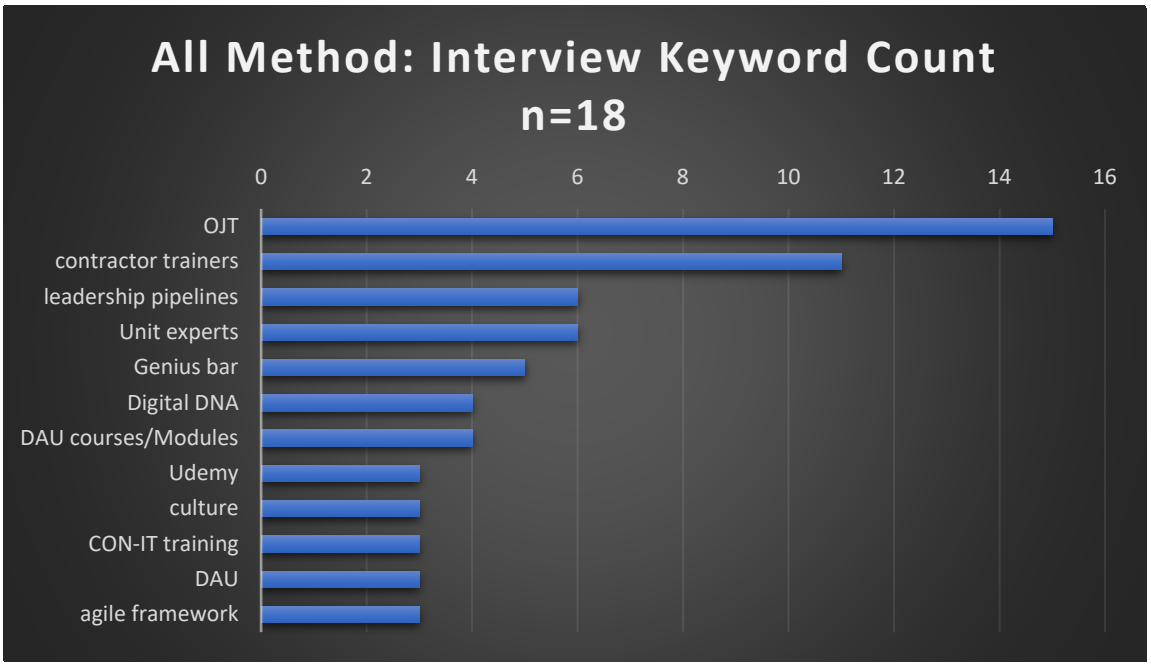


Figure 18. All Method: Interview Keyword Count

Figure 19 further breaks out current types of methods from the method theme. I addressed the results for nearly all the top four most common terms in the previous sections. The remaining term is the third most commonly occurring phrase from this subsection, “teamwork.” Members of the data literate group cited teamwork as being critical to success in the current data literacy efforts. This could indicate that there is more than just a

traditional training structure required to facilitate the roll out of data literacy training across the USAF contracting enterprise. There may also be a need for a collaborative team environment working toward a training goal. This does not fall specifically into one of the three primary types of delivery methods, in-person, asynchronous e-learning, or synchronous e-learning, but it may be valuable to consider for the successful application of any of these types of trainings.

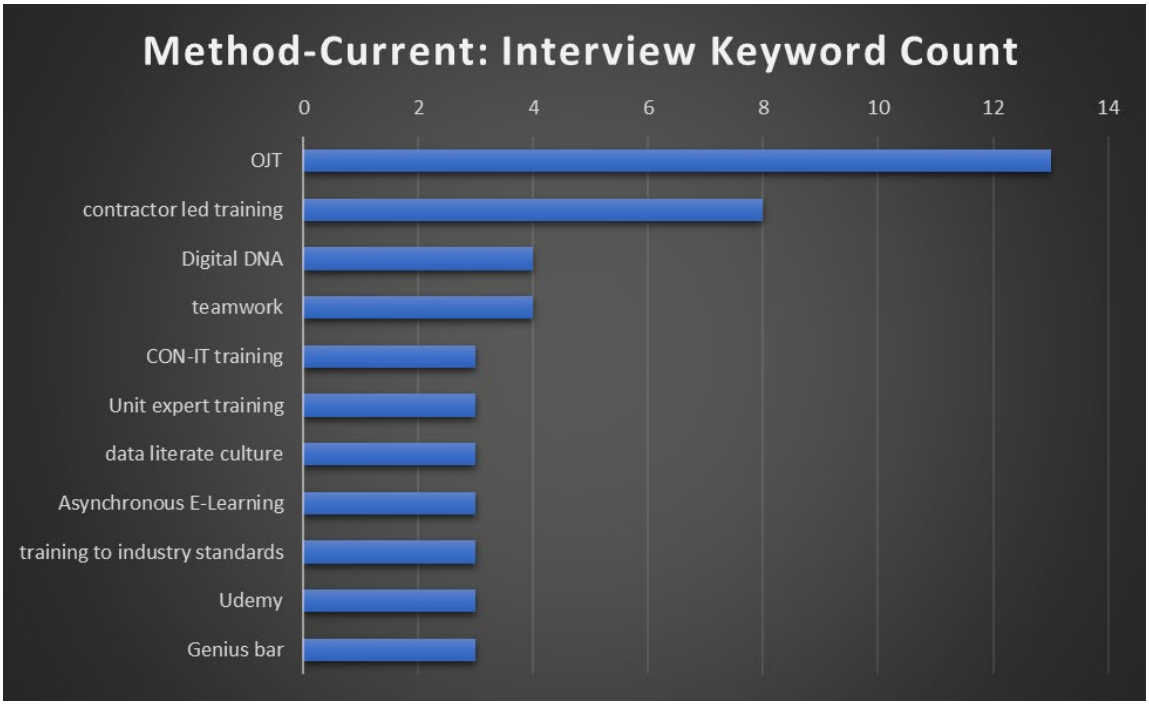


Figure 19. Method-Current: Interview Keyword Count

Figure 20 summarizes the expressed desired method that all interviewee groups identified. The most common phrase is "Defense Acquisition University (DAU) courses, certifications, and modules." These have been the primary methods of delivering uniform contracting education across all DOD services. This method consists of both asynchronous e-learning classes, provided via the dau.edu portal, and in-person traditional classes at regular intervals throughout a contracting professional's career progression. It is important to note that this certification model, known as the Defense for Acquisition Workforce

Improvement Act (DAWIA), was replaced by a Back-to-Basics talent management framework as of 1 October 2021 (Tenaglia, 2021).

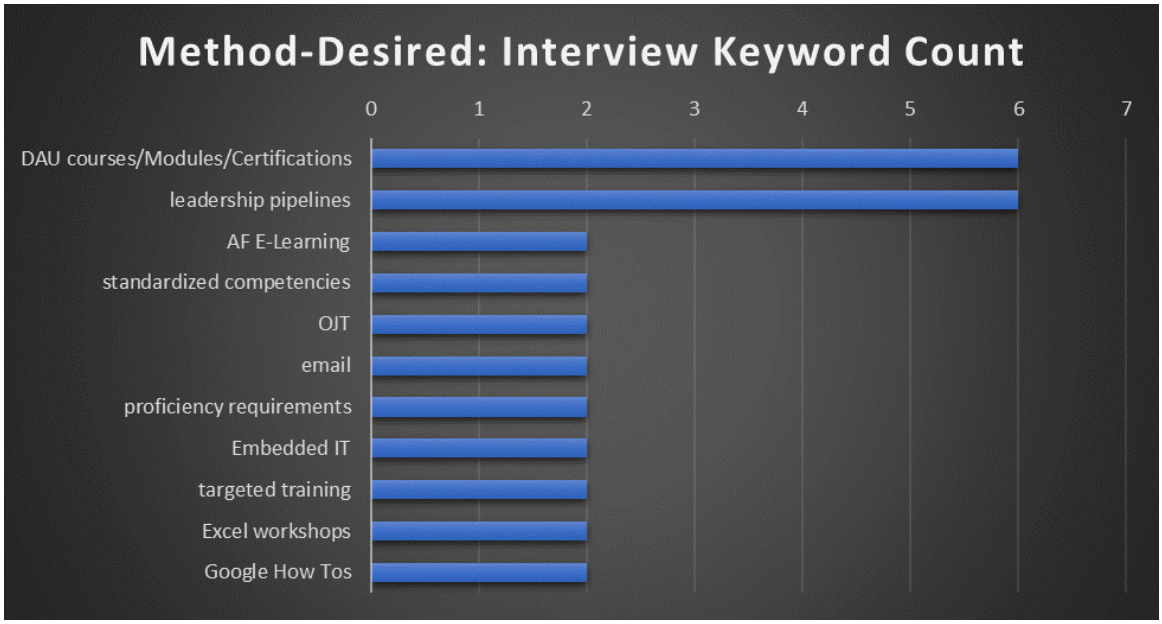


Figure 20. Method-Desired: Interview Keyword Count

D. INTERVIEW THEMATIC ANALYSIS RESULTS FOR DATA LITERACY METRICS

Figure 21 provides the summarized data of all interview responses that I assigned to the metrics category. This figure is for transparency purposes only, as I was unable to validate the categorical binning for this theme. My inability to validate my word categorizations could be because the inherent complexity of measuring data literacy. This finding is therefore telling in its own way and does line up with both the findings of metrics from the literature review section and the interview responses given by all three data literacy groups. The data leaders group had members mention that metrics for success has been one of their biggest challenges to identify, and ultimately, they rely on participation and feedback in offered services to assess their program's success. As mentioned, I found that almost all methods of measuring data literacy were either entirely subjective, and based on individual self-assessment, or extremely labor intensive, requiring a data literacy expert to assess a comprehensive product provided by the assessed person.

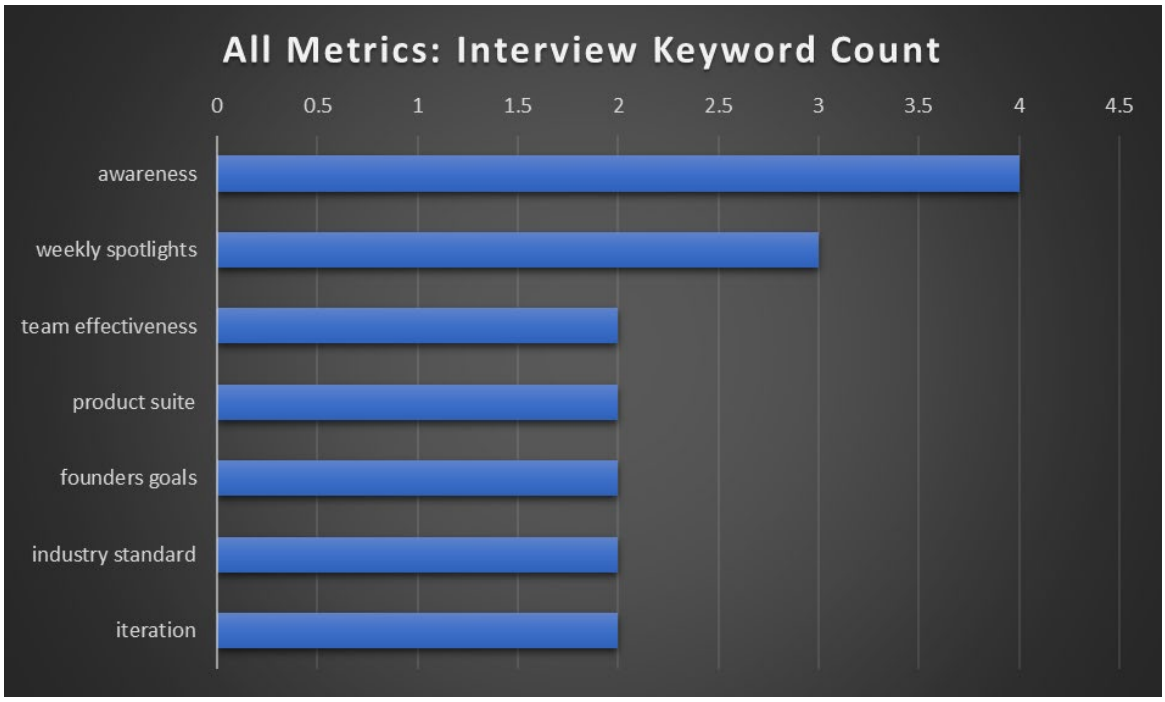


Figure 21. All Metrics: Interview Keyword Count

E. EXECUTIVE EDUCATION THEMATIC ANALYSIS RESULTS FOR DATA LITERACY

Figure 22 shows the most common subjects and skills taught in all 47 executive education programs analyzed. I used published course descriptions and target audience information to break down the courses into groups of target audiences to provide maximum analytic value for the timing component of my research question.

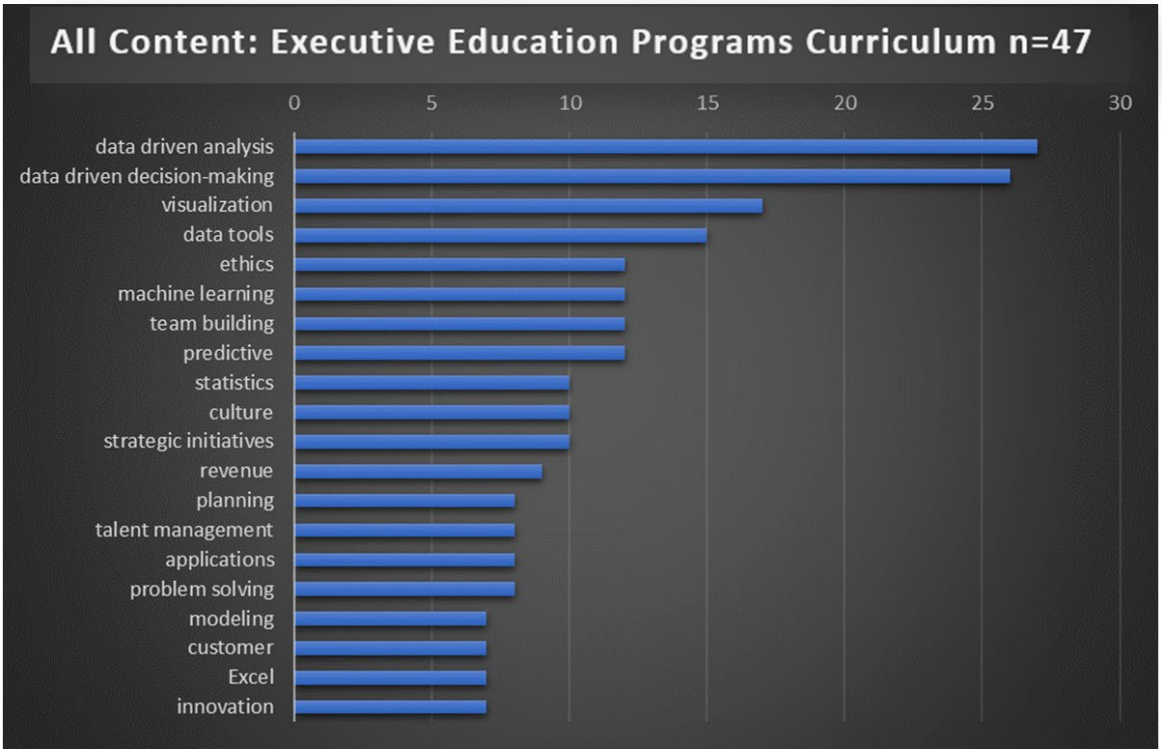


Figure 22. All Content: Executive Education Programs Curriculum

Figure 23 shows that the top three most common content from the entry-level executive education courses are in order: "data-driven analysis," "visualization," and "decision-making." This indicates that an initial foundation of data literacy skills requires the ability to analyze, create visualizations and use those products to make data driven decisions. This aligns with the results from the literature review sections for expert definitions, as shown in Table 2. In this section decision-making was the third most common defined skill, analysis was sixth, and visualization was fifteenth. While decision-making and analysis are not far off from the most referenced phrases, the significant difference in visualization might be attributable to the increased focus of industry on the use of visualizations compared to academic expectations.

In the content section from academic research, decision making was absent, data visualization was second and data analysis/interpretation was fifth. In this case, visualization and analysis ranked similarly for importance, while decision making is

missing entirely. This may be because the content from academia is focused on students versus the workforce, or simply the adoption of data-driven decision making as a common term.

The next three most common skills taught in the entry-level trainings are: "ethics," "statistics," and "customer focus." This agrees with my dominant definition and establishes that basic education in data literacy must include an understanding of ethical data use. Additionally, academic content summaries and the DOD AI education strategy identify statistics as critical. This highlights the importance of basic statistics skills when attempting to embed data literacy in an organization. Finally, there is an understandable emphasis on having a customer focus, as these programs are all meant to be used to increase data literacy of members of the workforce, and as such should focus on customers to be of the most value for the company's investment. This is also informative for the USAF contracting career field. Contracting is considered to be a customer service organization and as such, understanding the needs of our customers and how to help them to improve their data literacy is a skill that could prove invaluable to the whole organization.

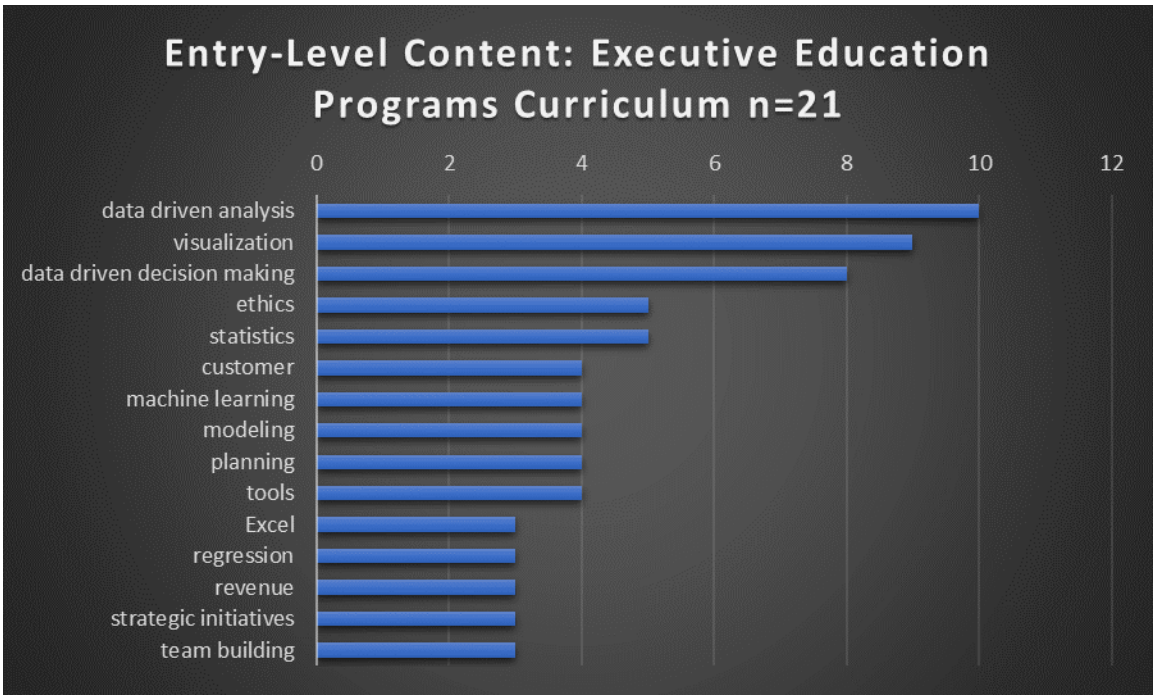


Figure 23. Entry-Level Content: Executive Education Programs Curriculum

Figure 24 shows that the top three most common content from the mid-level executive education courses are, in order: “data driven decision making,” “data driven analysis” and “visualization.” These are the same top three from the entry-level content, in a different sequence. The upgrade from third position in entry-level to first position in mid-level is telling and shows the increased emphasis placed on the need for informed data driven decision making for those who are transitioning into management positions. Additionally, the continued emphasis on analysis and visualization could indicate that while mid-level employees may be more focused on decision making, they still need to have a basic understanding of analysis and visualization to use the data related work coming from entry-level employees.

The next three most frequent subjects are: “predictive,” “tools,” and “machine learning.” These are concepts that did not arise in the top six terms from entry level curriculums. This may be attributed to the added complexity of both predictive and machine learning concepts. Tools may be elevated for this same reason. The data tools and skills required to apply predictive and machine learning concepts are more advanced that those more basic skills, such as visualization and basic analysis, and therefore would require more targeted training. Unfortunately, there were no consistent names of types of tools mentioned to confirm this theory.

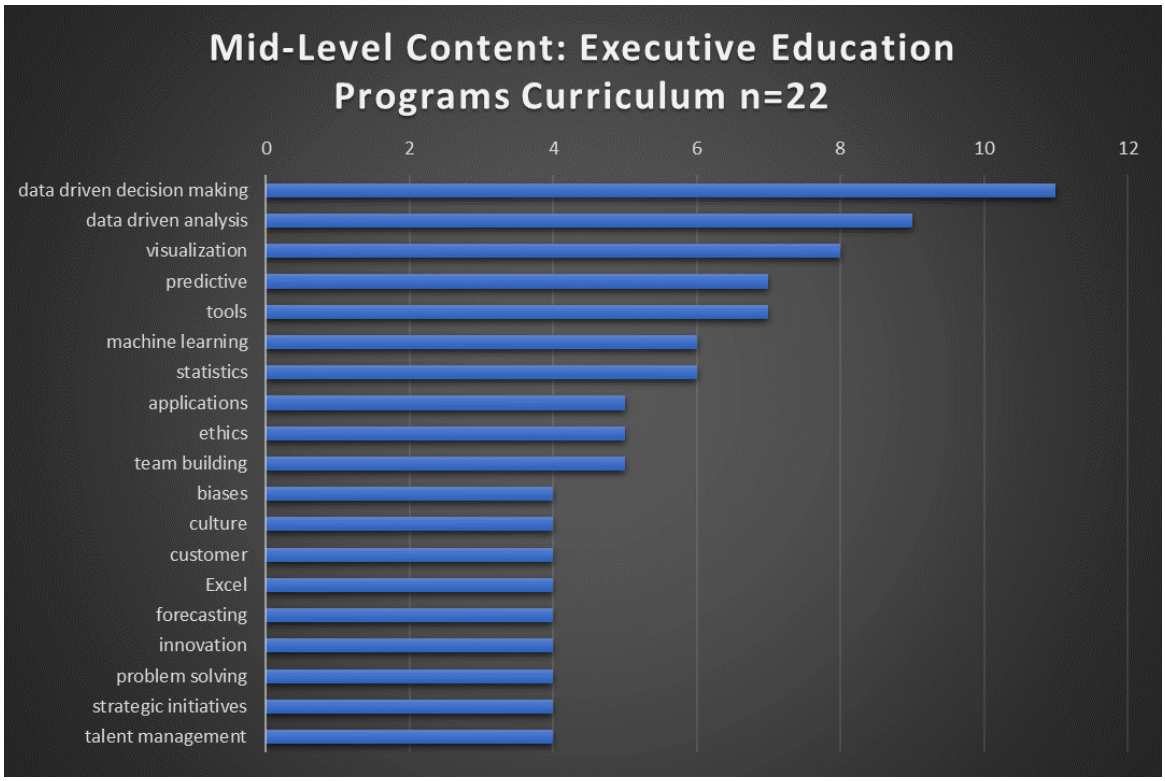


Figure 24. Mid-Level Content: Executive Education Program Curriculum

Figure 25 shows that the four most frequent skills taught in senior-level programs are "decision-making," "data-driven analysis," "applications," and "machine learning." The continued dominance of decision making, data driven analysis and machine learning is predictable, as senior-level management would be expected to focus on those as much as mid-level management is. Applications, however, is a new dominant topic. Course descriptions often use this term to refer to AI applications specifically. The more advanced skills required for AI utilization makes it evident why this training exclusively emphasized in senior-level employee training focus. Additionally, senior leaders required to understand the data tools available to them and are also likely to be responsible for the purchase and implementation of any new AI applications that would be adopted. Educating senior leadership on the most current tools and applications available could be critical to success at this level.

The fifth and sixth most common terms in this echelon are "ethics" and "visualization." I addressed these in both the entry and mid-level analysis sections, and no further insights are apparent from their existence in the senior-level curriculums.

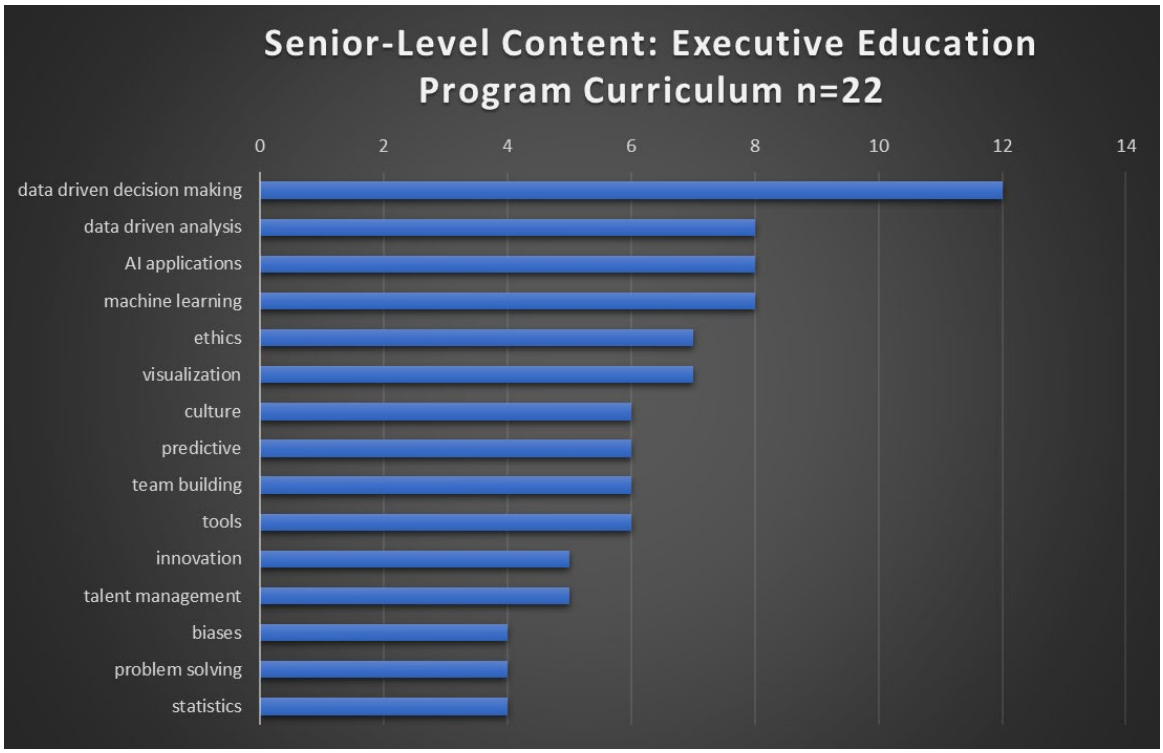


Figure 25. Senior-Level Content: Executive Education Program Curriculum

F. EXECUTIVE EDUCATION QUANTITATIVE ANALYSIS RESULTS FOR DATA LITERACY

Tables 11, 12, and 13 are the basic descriptive statistics results for all executive education programs analyzed. Figures 26, 27, and 28 show the scatterplot results for all executive education programs' length of course, on the x axis, and their corresponding cost on the y axis.

Table 11. Asynchronous e-learning Executive Education-Qualitative Analysis Summary Statistics

Days		Price/PP Online	
Mean	36.1338	Mean	$3,369.8947
Standard Error	13.5765	Standard Error	$1,316.3841
Median	5	Median	$2,600
Mode	30	Mode	$39
Standard Deviation	59.1784	Standard Deviation	$5,737.9854
Sample Variance	3,502.0811	Sample Variance	$3,2924,477.43
Kurtosis	8.2121	Kurtosis	15.2563
Skewness	2.7015	Skewness	3.73819
Range	241.5417	Range	$25,980
Minimum	0.4583	Minimum	$20
Maximum	242	Maximum	$26,000
Sum	686.5417	Sum	$64,028
Count	19	Count	19

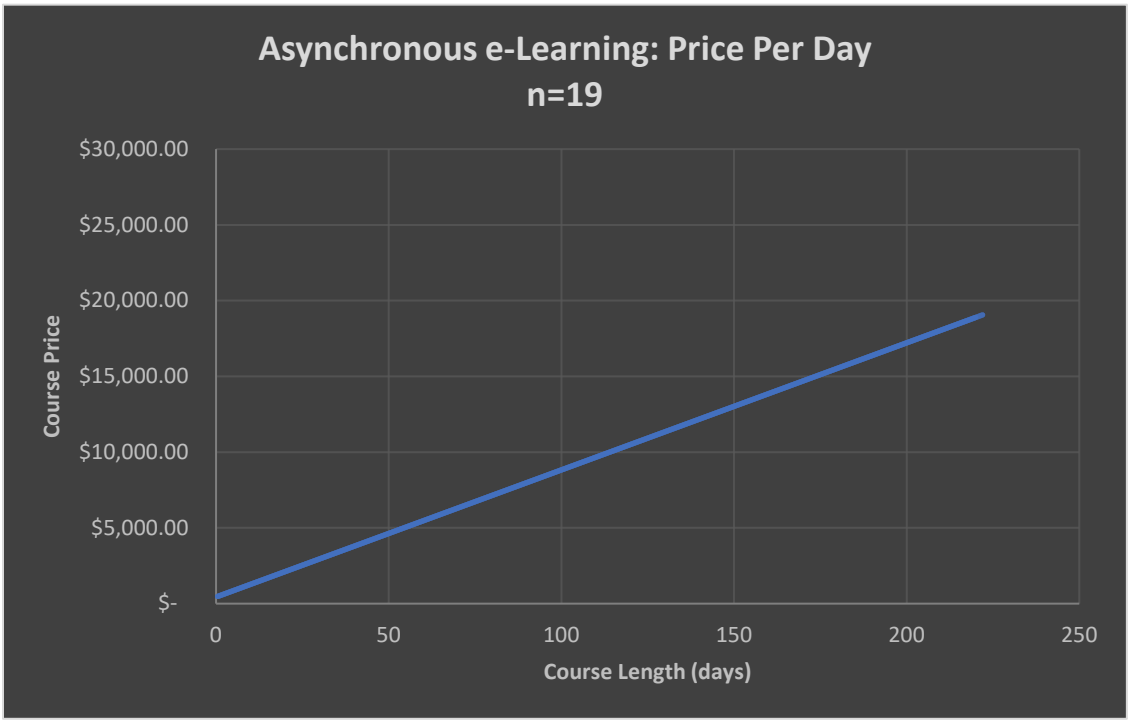


Figure 26. Asynchronous e-learning Executive Education-Data Point Scatterplot

Table 12. Synchronous e-learning Executive Education-Qualitative Analysis Summary Statistics

Days		Price/PP Online	
Mean	7.6667	Mean	$3,106.75
Standard Error	3.0806	Standard Error	$731.4965
Median	2.5	Median	$2,950
Mode	2	Mode	$2,950
Standard Deviation	10.6714	Standard Deviation	$2,533.9783
Sample Variance	113.8788	Sample Variance	$6,421,046.386
Kurtosis	2.1175	Kurtosis	-0.5178
Skewness	1.8691	Skewness	0.7144
Range	29	Range	$7662
Minimum	1	Minimum	$138
Maximum	30	Maximum	$7,800
Sum	92	Sum	$37,281
Count	12	Count	12

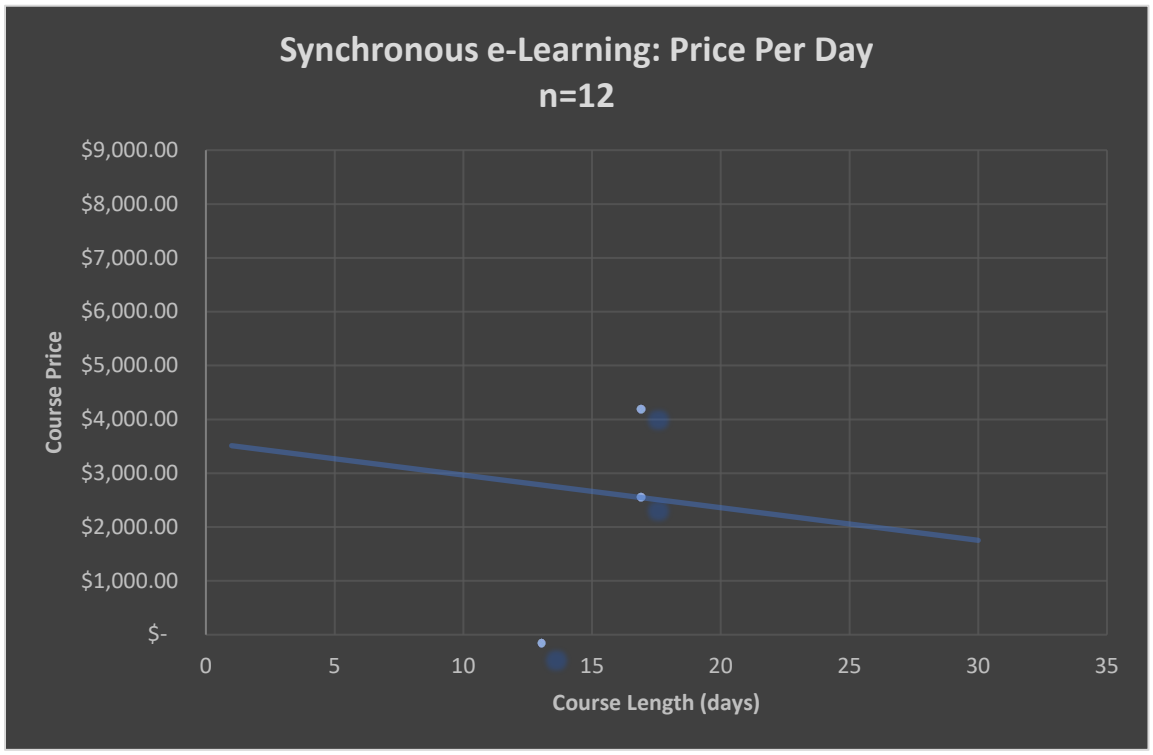


Figure 27. Synchronous e-learning Executive Education-Data Point Scatterplot

Table 13. In-Person Executive Education-Qualitative Analysis Summary Statistics

Days		Price/PP (In-Person)	
Mean	3.25	Mean	$5,828.125
Standard Error	0.403112887	Standard Error	$1,031.6347
Median	3	Median	$4,450
Mode	2	Mode	$2,950
Standard Deviation	1.6125	Standard Deviation	$4,126.5389
Sample Variance	2.6	Sample Variance	$17,028,322.92
Kurtosis	-1.014370245	Kurtosis	-0.9071
Skewness	0.6270	Skewness	0.6167
Range	5	Range	$13,000
Minimum	1	Minimum	$0
Maximum	6	Maximum	$13,000
Sum	52	Sum	$93,250
Count	16	Count	16

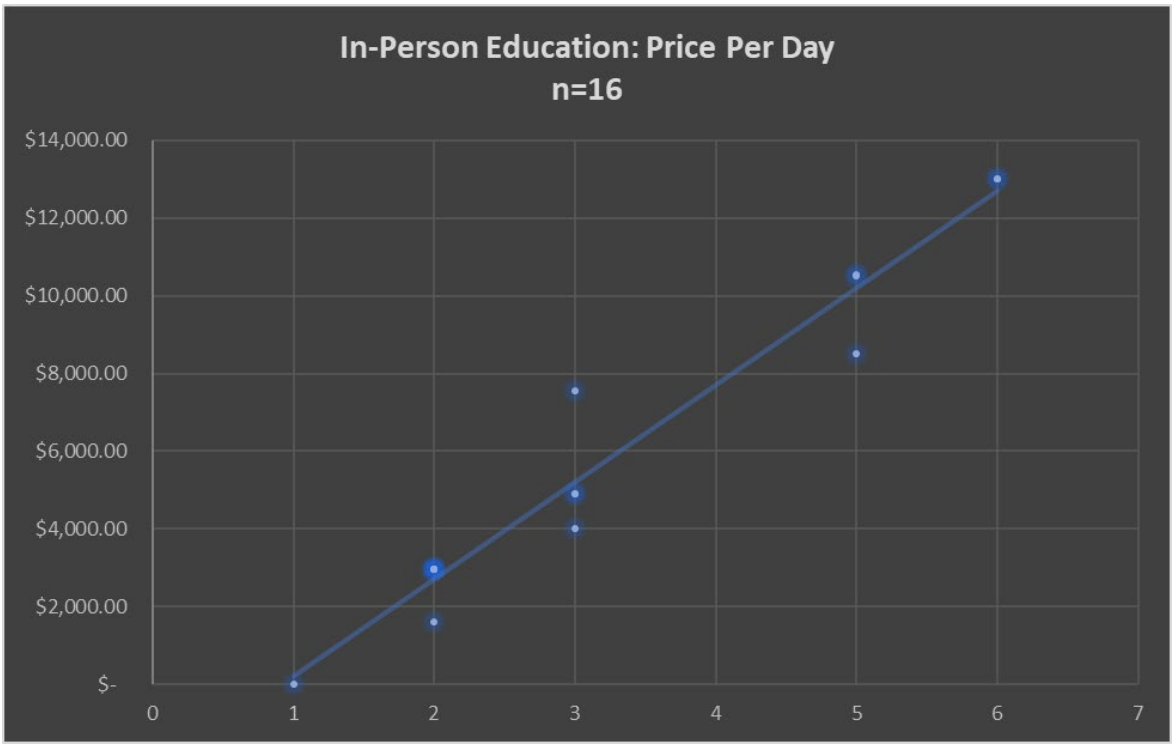


Figure 28. In-Person Executive Education-Data Point Scatterplot

The price variability between these training delivery methods is in the first and second rows of Table 14, average cost per day and median cost per day. Both rows show an increasing average cost per day as you increase in the level of interaction required, with an astronomical jump of 332.4% between asynchronous and synchronous, with another significant jump in price of 162.4% between synchronous and in-person learning. Overall, this shows that, as expected, the cost per day for training increases as we move from the more cost-effective, flexible method of asynchronous e-learning toward the higher demand, high cost traditional in-person methods.

Table 14 shows that for both asynchronous e-learning and in-person learning, the price of the program and the length of the course are highly correlated, 0.8040 and 0.8250 respectively. I expected this as this is a typical pricing model for most services, the price of the service increases as the length of the service increases. The finding that synchronous e-learning is not only not highly correlated, but also weakly negatively correlated is a surprising finding. I found that one possible reason for this is an anomaly caused by the COVID-19 response in the education industry. Many programs in the synchronous e-learning delivery data set are either offered both via synchronous e-learning and in-person learning or were structured for in-person training and moved to an e-learning format due to the pandemic. While there is no data to indicate which programs prices changed as a result, if the providers did not adjust the prices, this may explain the discrepancy. Programs that were always synchronous e-learning would likely have a more economic pricing model than the more expensive originally in-person programs.

Table 14. All Executive Education-Key Coefficients/Averages

	Asynchronous e-learning	Synchronous e-learning	In-Person
Average Cost/Day	$295.67	$982.81	$1,595.94
Median Cost/Day	$93.33	$1,432.50	$1,554.17
Correlation Coefficient for Price with Length in Days	0.8040	-0.2552	0.8250
R-Squared	0.7340	0.1207	0.9653

G. SYNTHESIZED DATA FROM LITERATURE REVIEW, INTERVIEWS, AND EXECUTIVE EDUCATION

Due to the vast amount of information and complexities of existing USAF contracting training structures, I found it necessary to synthesize all of the qualitative results from both my data analysis and information from the CFETPs into infographics. These images use large gears to represent both the three different levels of target audiences found in executive education and CFETP pyramids. The infographics use small gears to represent the typical progression of duty titles of enlisted and officer contracting professionals. The rectangles contain a summary of what content each data source recommended for each target audience level.

Figures 29 and 30 show both the large gear target audience levels and typical USAF contracting position progression for both enlisted and officers. Figure 31 shows the summarized recommended content data for all entry-level positions. This section is where I summarized all interview content recommendations, since there was no data collected in the interviews to suggest when suggested data literacy events occur. Figure 32 depicts the recommended content for mid-level audiences and Figure 33 shows the suggested content for senior-level positions. For the level of training required, each of the four sources, interviews, gold standard narrative documents, DOD AI education plan, and executive education content summary, used different terminology to explain the level of training expected from individuals. I attempted to marry the differing terminology for the level of training required from each source into simplified beginner, intermediate, and advanced categories used in the DOD AI education plan. Unfortunately, due to the subjectivity of this, I cannot provide a perfect definition of what each level of training requires in terms of content mastery.

I compared these four content areas and looking at them I noted that there are varying levels of specificity. The formatting of the text in this infographic represents those degrees. Content items that are very vague and general are normal font, items that are extremely specific and targeted are in bold lettering, and an asterisk precedes items that are unique to only their area.

Figure 29. Officer Timing Summary Infographic Adapted from: USAF, (2017)

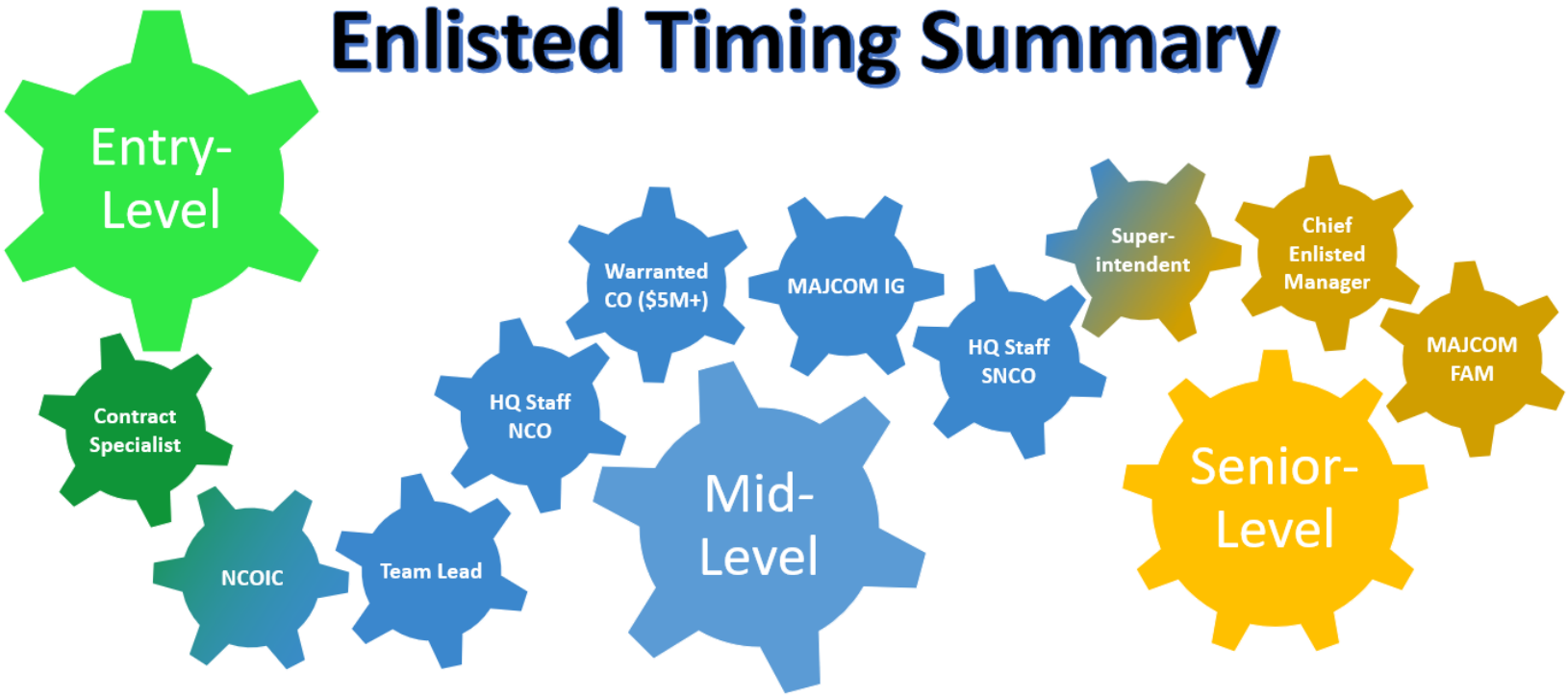


Figure 30. Enlisted Timing Summary Infographic Adapted from: USAF, (2017)

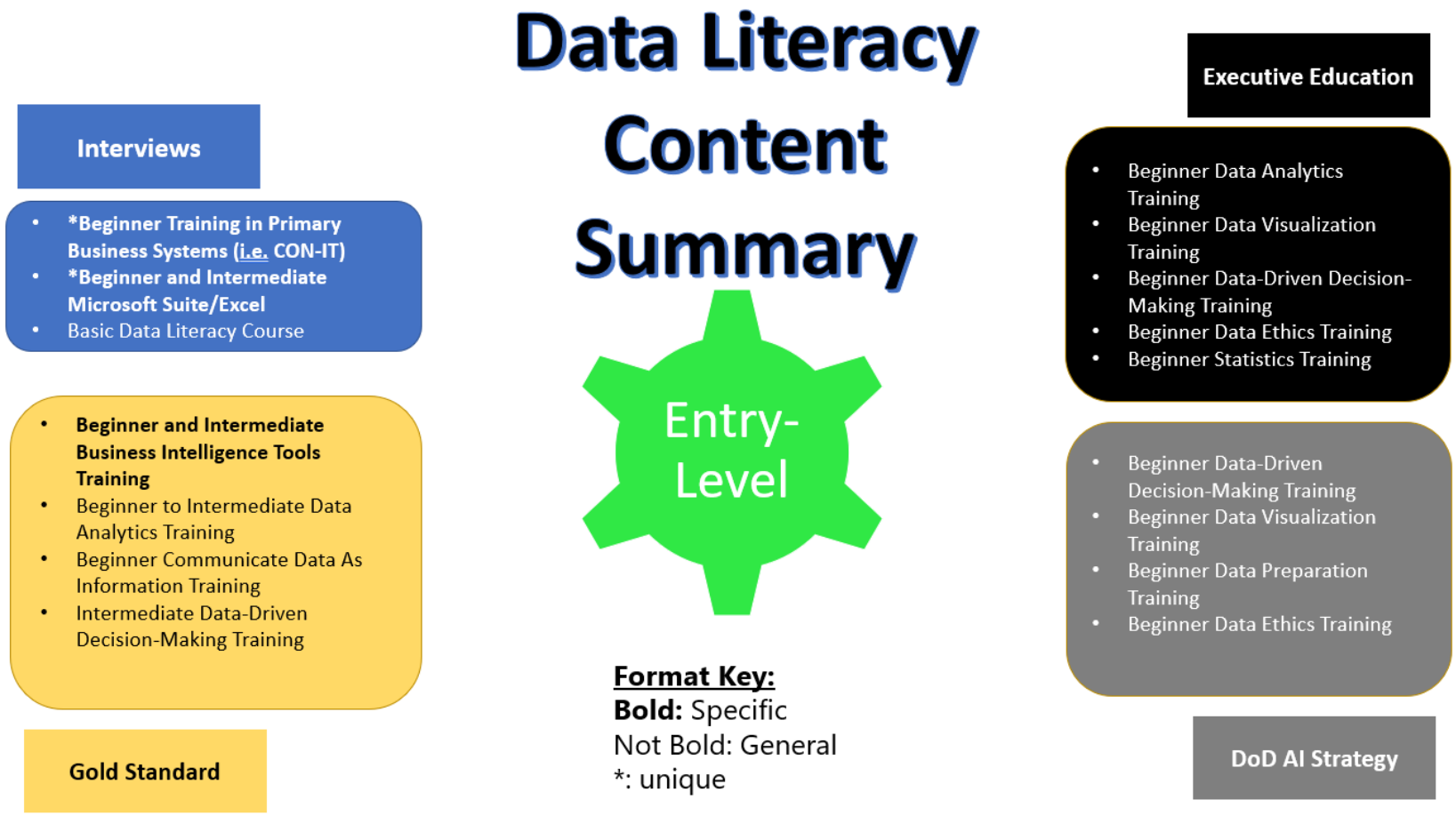


Figure 31. Data Literacy Entry-Level Content Summary Infographic

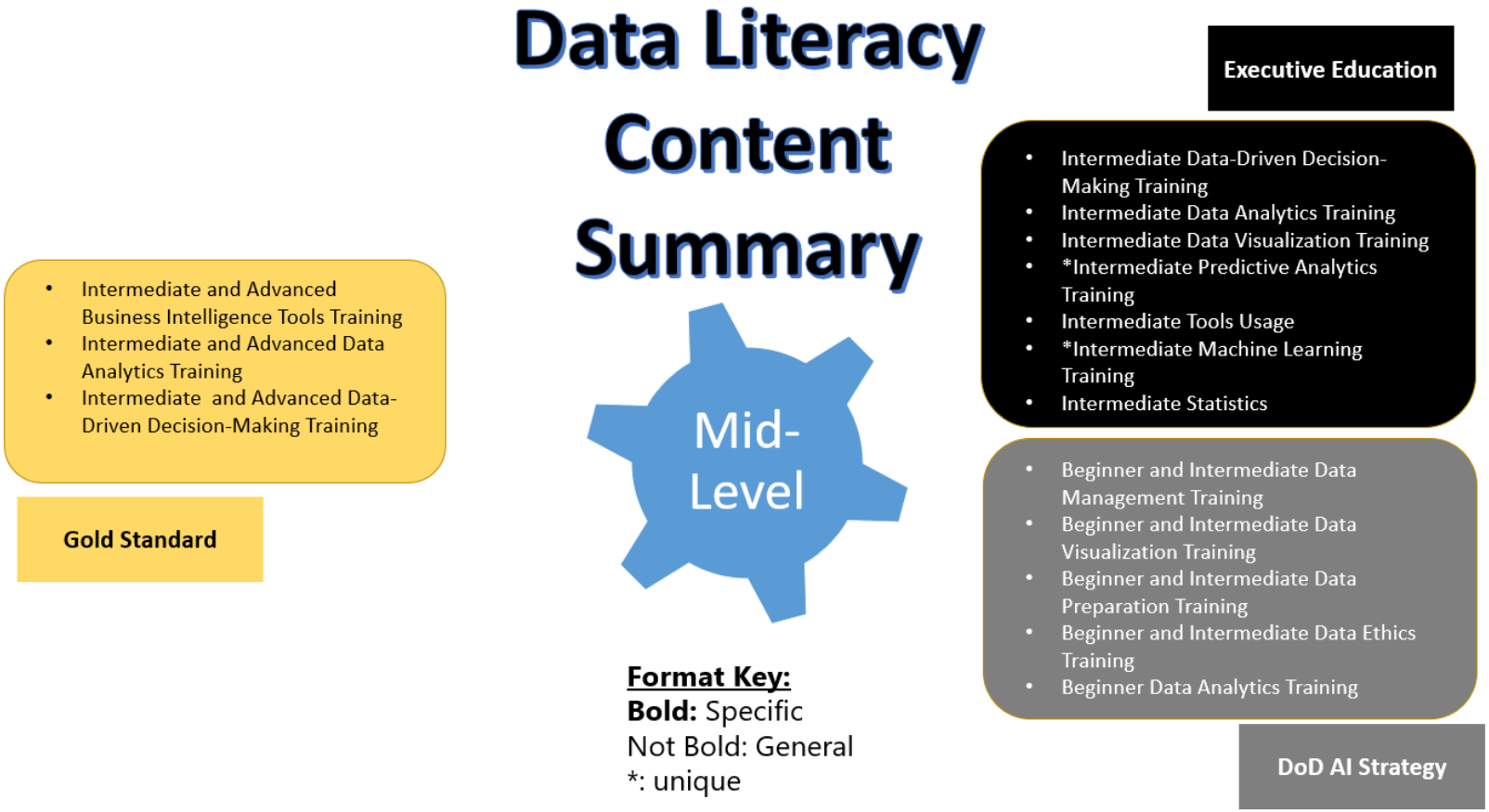


Figure 32. Data Literacy Entry-Level Content Summary Infographic

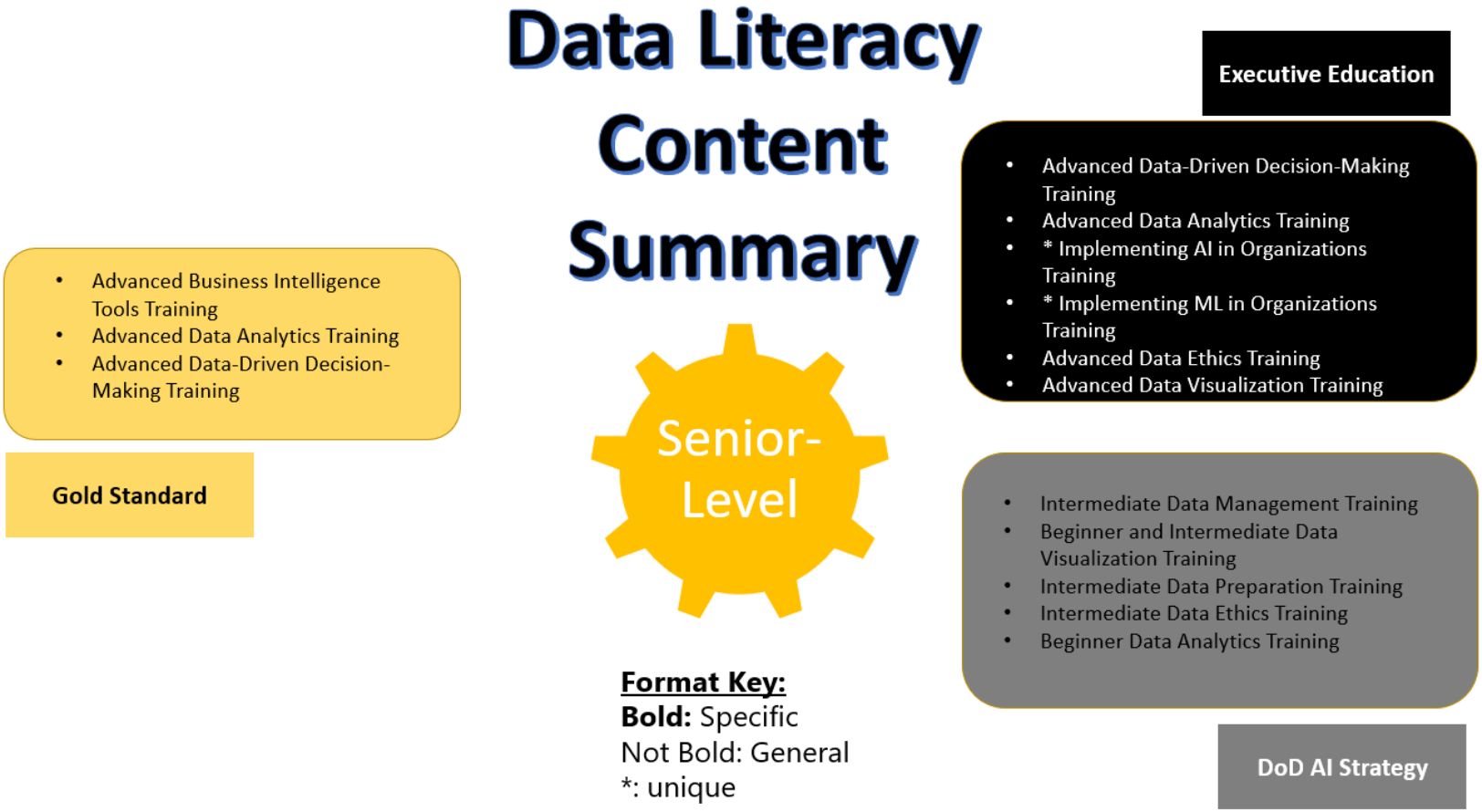


Figure 33. Data Literacy Entry-Level Content Summary Infographic

H. DATA LIMITATIONS

As noted previously, this data collection does have some limitations. First, the data provided in the analysis of Gold Standard data literacy expectations is limited to military personnel. This is because these two categories of contracting professionals, when compared to their civilian counterparts, follow a linear career progression path due to the nature and structure of the military structure. However, even with the higher likelihood of a structured path for these groups, this path is in no way universal, nor does it represent all possible career progression possibilities and times. Further research into the structure of the civilian workforce career progression is necessary.

The interview data collected for this research represents a small sample of most of my interviewee populations. The data leaders group was the most comprehensive, representing the entirety of the data literacy campaign team. However, it still did not encompass all possible leaders in USAF contracting who work on data literacy goals. The other two groups represent a very small portion of both the Kessel Run Team, which consists of over 1400 members, and the commissioned officer contracting corps, which has over 700 officers. Therefore, these findings must be viewed as a case study vs a generalizable result representing the entire population for any of these groups.

V. CONCLUSION AND RECOMMENDATIONS

A. RESEARCH QUESTIONS ANSWERED

This research sought to answer three questions regarding how the USAF could structure a data literacy program to increase the knowledge skills and abilities of its workforce. Analysis of interviews, openly available curriculum data and academic experts offers answers to some of these questions. This study also provides recommendations for USAF contracting leaders and areas of future research. The conclusions follow each of the original questions as posed.

- Research Question 1: How should the USAF align workforce data literacy development to contracting knowledge, skills and ability requirements to deliver the appropriate content for Mission-Focused Business Leaders (MFBLs)?

Analysis of the various sources of information provides a good idea of what data literacy related KSAs contracting professionals should acquire to improve their performance as MFBLs. Interview data indicates that existing members of the workforce feel that education in tools usage, such as CON-IT, associated contracting databases, and Microsoft Excel are critical to their success as MFBLs. The analysis of existing executive education programs suggests that ideal content for the workforce, without accounting for positional requirements, is training in data driven analysis, data driven decision making, and visualization. These are supplemental to directive requirements already set in place by military leadership. The DOD AI strategy sets a minimum requirement for skills in data management, visualization, ethical data use, mathematics, statistics, and data science. Finally, the contracting career field has set forth specific data skills for tools usage, technical skills and leadership skills it requires from its workforce. These set forth a well-researched list of tasks that I believe should be considered when attempting to create a roadmap for instilling data literacy KSAs in USAF MFBLs.

- Research Question 1(a): Once appropriate data literacy content is identified, what is a potential time, modality, and metrics for the delivery of this content?

Since I have compiled an extensive list of data literacy content suggestions, it was important to look at other factors necessary for a training program, specifically timing, modality and metrics. A theme throughout my existing data literacy program research found that a critical component of any data literacy program is the tailoring of training requirements and expectations to match the expectations of a team member's work responsibilities. After reviewing existing directives and educational standards, I believe that the most appropriate way to divide the USAF military contracting career field positions according to industry standard categories: entry-level, mid-level, and senior level. In addition to these summaries, using the existing CFETPs I was able to divide established contracting positions into each of these categories. The results of this are summarized in the infographic in Appendix B.

Method of delivery data provided a much less definitive conclusion. Existing research finds that e-learning can prove to be an effective training method, especially in comparison to price. Quantitative analysis on existing programs proves that the expected cost model, increasingly expensive depending on interactivity requirements, holds true in data literacy training. Interview data shows that e-learning is already an accepted and established model within the USAF contracting education program. Unfortunately, the lack of solid metrics with which to judge a curriculum by, makes a definitive conclusion of the best method of delivery impossible to determine without further study. However, it is apparent that there is a wide range of options for the various delivery methods available for use by contracting professional development.

Finally, metrics was the weakest area of the research question themes results. There do not appear to be any solid recommendations for concrete metrics from either industry, academia, or interview data. While some metrics do exist, in the form of subjective self-assessment or in time intensive product review, they do not provide a consistent enough

answer to definitively state any potential metrics for measuring program success. Data literacy metrics requires the most extensive future research focus.

- Research Question 2: What are some uncovered best practice methods for the USAF contracting career field to take into consideration?

While thematic analysis did not reveal any specific best practices, certain excerpts from the data literate group and from academic publications provides some basic insights into this question. Kessel Run members have a unique organization that provides members opportunities for continuous learning with access to educational resources such as Pluralsight., a technology focused online learning platform. While access to the resources is commendable, I believe that the reason that those tools have the awareness and usage that they do is because of the innovation centric culture that Kessel Run has managed to create. Multiple interviewees spoke about the almost industry like innovation culture that exists in the organization, and members cited this as critical to not only the gaining the self-motivation to use educational resources provided, but also as a catalyst for members to seek out their own innovative forms of education. Leadership encourages members to look for educational opportunities such as internships and workshops and pitch decision makers on the value of investing their time and money in those programs. Multiple academic resources and government documents also cited a data literate focused culture as being critical to the success of data literacy programs. Therefore, if the USAF contracting hopes to truly improve the overall organizational data literacy, it needs to ensure that it provides a clear message of its commitment to a data literacy focused culture and advertises any tools and programs that are available to members to achieve it.

B. RECOMMENDATIONS FOR IMPLEMENTATION

I recommend that the USAF contracting career field create three "timing groups" to match with executive education target audience categories: entry-level, mid-level, and senior level. These match up well with current categories identified within the CFETPs.

Within each timing group the USAF contracting career field should find a resource to provide the following content and level of training. The entry-level timing group should attain the kinds of training shown in Table 15 during their time in that career category.

Mid-level data literacy recommendations are detailed in Table 16 and senior-level data literacy recommendations are found in Table 17. Please note, I found no necessary order of precedence of content instruction.

Table 15. Entry Level Data Literacy Training Recommendations

Entry-Level Data Literacy Recommendations
Beginner and Intermediate Microsoft Suite/Excel
Basic Data Literacy Course
Beginner Data-Driven Decision-Making Training
Beginner Data Visualization Training
Beginner Data Ethics Training
Beginner Data Preparation
Beginner Statistics Training
Beginner and Intermediate Business Intelligence Tools Training
Beginner to Intermediate Data Analytics Training
Beginner Communicate Data as Information Training
Beginner to Intermediate Data-Driven Decision-Making Training

Table 16. Mid-Level Data Literacy Training Recommendations

Mid-Level Data Literacy Recommendations
Intermediate and Advanced Business Intelligence Tools Training
Intermediate and Advanced Data Analytics Training
Intermediate and Advanced Data-Driven Decision-Making Training
Intermediate Data Visualization Training
Intermediate Predictive Analytics Training
Intermediate Machine Learning Training
Intermediate Statistics
Beginner and Intermediate Data Management Training
Beginner and Intermediate Data Preparation Training
Beginner and Intermediate Data Ethics Training

Table 17. Senior Level Data Literacy Training Recommendations

Senior-Level Data Literacy Recommendations
Advanced Business Intelligence Tools Training
Advanced Data Analytics Training
Advanced Data-Driven Decision-Making Training
Implementing AI in Organizations Training
Implementing ML in Organizations Training
Advanced Data Ethics Training
Advanced Data Visualization Training
Intermediate Data Management Training
Intermediate Data Preparation Training
Intermediate Data Ethics Training

To simplify these recommendations, I have created an infographic that can be found in Appendix B. This infographic should be a good tool for decision makers to use to help inform decisions on what content and timing should be considered when implementing a data literacy training program.

C. CONSIDERATIONS FOR FUTURE RESEARCH

Further research is still necessary to determine the ultimate metrics and methods that any successful data literacy program would incorporate. The limited scope of my data did not allow for a comprehensive analysis of the current level of USAF contracting professional's data literacy, nor did it allow for me to determine the metrics that matter to each organization. To provide solid metrics, USAF contracting leadership would need to identify quantifiable outcomes or skills that it desires in its contracting career force. Once leaders establish these metrics, a researcher could conduct a cost-benefit analysis of available programs to provide leadership with the most beneficial method of delivery for each identified learning outcome. Establishing the right metrics of success open up the area of data literacy research which would allow for complete causal modeling of timing, content and methods to preferred outcomes.

There were also multiple other agencies and career fields that I found provided some sort of data literacy education to its members. I did not use these programs as benchmarks in my own research because I was unaware of them until late in the research

process. Another vein of research could be a case study review of what these programs are, how they are implemented, and whether USAF contracting professionals have the ability to participate in them.

APPENDIX A. INTERVIEW QUESTIONS

A. DATA UNTRAINED SERVICE MEMBER QUESTIONS

1. How does your current or prior organizations define data literacy?
2. How has your current or prior organizations attempted to improve its members data literacy?
3. Examples can include but are not limited to, OJT for current systems, formalized training available for systems such as Excel, Access, Tableau, R, Python, etc.).
4. Yes? Please give details (what, when, how, etc.)
5. Has your organization made its members aware of upcoming DOD expectations to create an AI/Data literate military workforce?
6. If so, how did they communicate it?
7. (AF Members Only) Has your organization advertised and/or encouraged participation in current SAF/ACQI efforts (Genius bar, Q&A calls, SAF AQCI newsletters, lunch and learns, use of guides, Data contracting labs)?
8. Has the Air Force/DOD provided opportunities that were NOT specifically pushed by your current/prior organization that could be helpful in improving members data literacy?
9. If so, please provide details.
10. If provided, what efforts to increase data literacy did not work well for your organization?
11. Has any of your prior organizations had a particularly valuable member who had high data literacy skills?
12. What specific skills did they have that proved valuable?
13. Did the organization make efforts to get that member to train/educate others?

14. What skills/tools would be helpful for AF/DOD Contracting personnel to have more targeted training on?

15. Who else should I speak to about this topic?

B. KESSEL RUN INTERVIEW QUESTIONS

1. Does your organization educate its employees on Data Literacy?

2. If so, how does your organization define Data Literacy?

3. What is Kessel Run's mission?

4. Tell me the "origin story" of your program?

5. How the program was developed, who/what was it modeled after?

6. Does your organization provide literature on this subject and can it be shared with me for my research purposes?

7. Tell me about how the Kessel Run program works.

8. How long members are in "upgrade" status, specialty paths, ping pong tournaments, whatever is core to it.

9. Has the organization identified individuals within the program that serve as role models or whose contributions were determined to improve organization operations?

10. Please provide an example of when things did not go as planned for the organization and how (if) your organization adapted to the misstep.

11. How about a time when things went exactly to plan, what was it and what was different about that time then others?

12. Communication methods, delivery method, kismet timing, whatever

13. Describe a recent Kessel Run accomplishment that the organization has pointed to as "notable"? Why did the organization choose that event as the example?

14. What skills does Kessel Run teach that the organization has proven to be valuable to Contracting members outside of this unique organization.

15. Special skills that make contracting easier/more effective that might be beneficial if adopted by the Contracting workforce at large.

16. Looking back at the way Kessel Run trains its people, what is something that has been identified by the organization as an area that could be improved to make things better/more accessible for the layman?

17. Who else should I speak to about this topic?

C. DATA LITERACY CAMPAIGN TEAM QUESTIONS

1. What is your team's mission?

2. What are your team's key goals and objectives?

3. How will the team know it has succeeded?

4. Tell me about the key characteristics/areas of expertise for the DL Campaign team.

5. How were its members selected? What is their realm of expertise, relevant work history etc.

6. How does your organization define Data Literacy?

7. Please tell me how this program developed and evolved?

8. Where did it start, how long did it take to develop, what compromises did the organization have to make etc.

9. Would your organization be willing to share any literature/resources that it found useful?

10. Access to DL Campaign Max.gov team setting/literature review for current program

11. What (if any) programs/teams has the DL campaign tried to emulate?

12. What has the program determine to be its greatest challenges, and how have they been addressed?

13. Please provide an example of when things didn't work out like for the organization as planned and what lessons came out of it.

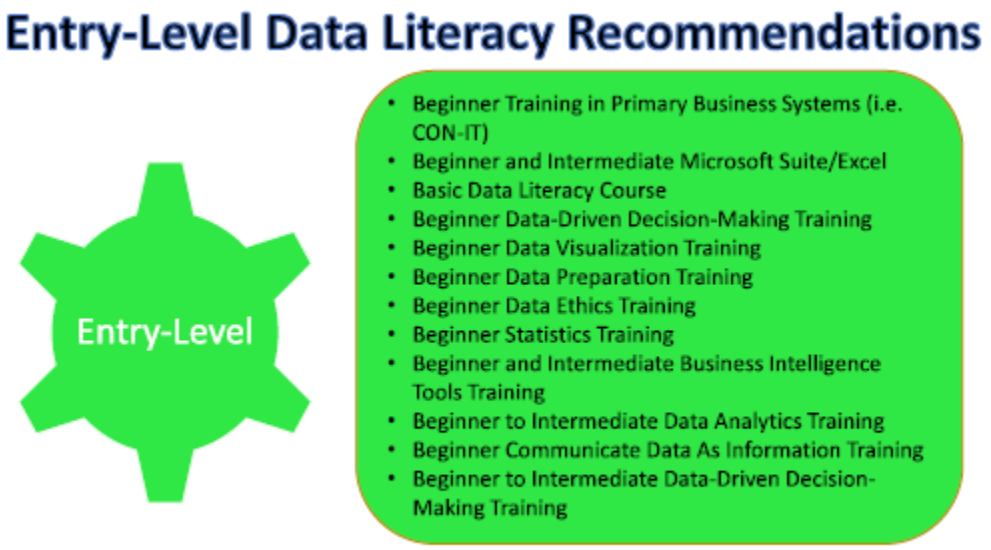
14. What has the organization determined is the campaign's greatest success story?

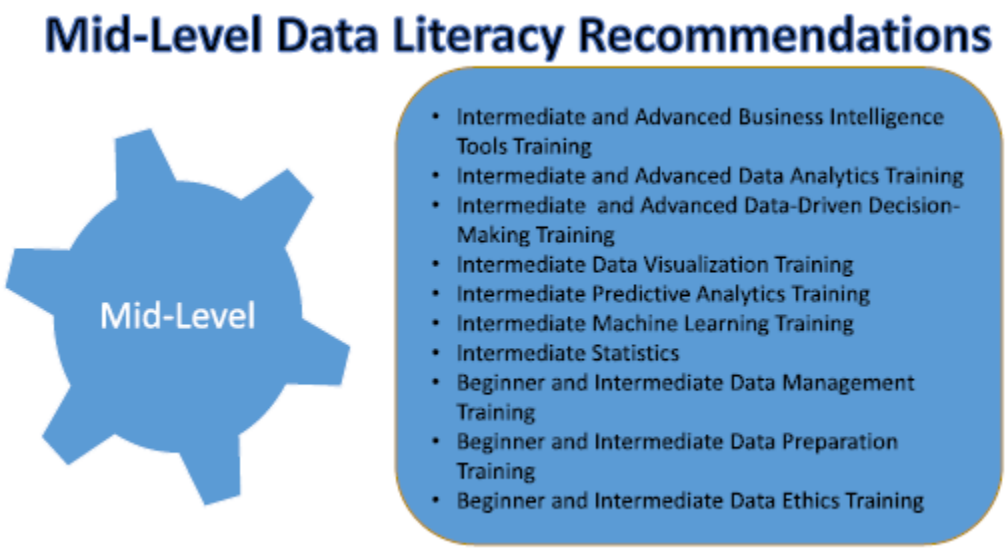
15. If it had every resource/option available to make the program a success, what would the organization ask for to help it achieve/surpass its mission?

16. Who have been identified as see as key organizations/stakeholders in this effort (aside from SAF/ACQI)?

17. Who else should I speak to about this topic?

APPENDIX B. DATA LITERACY RESEARCH INFOGRAPHIC





Senior-Level Data Literacy Recommendations

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