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Mapping Government Officials in Emerging Technologies Roles

Analysis of STEM Qualifications

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Overview

This study examines the alignment between the educational backgrounds and career experiences of U.S. Government (USG) civilian leadership officials in emerging technology roles.[1] Using data collected in Spring 2024 from Leadership Connect, USAJobs, Facebook, and LinkedIn, it analyzes the prevalence of STEM (Science, Technology, Engineering, and Mathematics) degrees and relevant career experiences among officials working across STEM roles, specifically among those concentrated on the former 14 emerging technology areas designated by the Under Secretary of War for Research and Engineering (USW(R&E)).[2] These areas are critical to national security and technological advancement, as outlined by the Department of War (DoW).[3] By identifying gaps and opportunities, this report aims to inform strategies for strengthening the USG's capacity to lead in critical technological domains.[4] The study's findings highlight the need for improved demographic data collection, recruitment strategies, and educational programs to enhance technical development in emerging science and technology fields. By focusing on these areas, the USG can support efforts to equip the civilian and defense sectors to handle future technological challenges and global competition, thereby advancing broader strategic objectives.

The core of the research is to understand the types of STEM qualifications individuals hold, including formal education, experience, and technical expertise, while in key technology roles, and to determine the qualifications or experience required for placement in key fields.

To contextualize the findings, Table 1 summarizes the key characteristics of the dataset.

Table 1: **Demographic and Professional Attributes of STEM Workforce**

Attribute Comparison	Sample Counts	Percentage of Total
Male	2,002	65.7%
Female	1,045	34.3%
STEM Prior Experience	813	26.7%
No STEM Prior Experience	2,234	73.3%
STEM Education	1,252	41.1%
No STEM Education	1,795	58.9%

Overall, the findings offer valuable insights into the composition of the STEM workforce in the public sector. While education and experience remain crucial, the study highlights the importance of further exploring factors such as career transitions, particularly the challenges associated with moving between public and private sectors. These transitions are critical to understanding how to better support professionals navigating these pathways. Additionally, the findings raise the question of whether leadership development, candidate networks, understanding the Pentagon's budget process, and the role of non-traditional candidates are potentially more important to filling senior technology roles than technical expertise. These insights have direct implications for workforce development strategies, recruitment practices, and education initiatives aimed at preparing the next generation of STEM professionals.

1 Emerging technology roles in this context refer to positions focused on critical technology areas, such as artificial intelligence, quantum computing, biotechnology, and others, as identified in the 2023 National Defense Science and Technology Strategy (http://www.cto.mil/wp-content/uploads/2024/05/2023-NDSTS.pdf). These roles include those within DoW, specifically focusing on civilian employees rather than military personnel. This distinction allows for a clearer understanding of workforce dynamics in civilian government sectors, where organizational structures, recruitment practices, and role requirements may differ from those of military counterparts.

2 The former 14 critical emerging technology areas identified by the Under Secretary of War for Research and Engineering (USW(R&E)) include: Biotechnology, Quantum Science, Future Generation Wireless Technology (FutureG), Advanced Materials, Integrated Network Systems-of-Systems, Trusted Artificial Intelligence (AI) and Autonomy, Directed Energy, Hypersonics, Integrated Sensing and Cyber, Human-Machine Interfaces, Renewable Energy Generation and Storage, Advanced Computing and Software, Microelectronics, and Space Technology.

3 Gaps in DoW and USG Personnel: The focus on the DoW's identified areas is due to their overlap with broader USG strategic interests in maintaining national security and technological leadership. While the study highlights gaps primarily within DoW civilian personnel, the implications extend across the USG due to the interconnected nature of defense technologies and civilian applications. Addressing these gaps is vital not only for military preparedness but also for enhancing the USG's overall capacity to innovate and respond to emerging technological challenges.

4 Ibid.

Introduction

The 2023 National Defense Science and Technology Strategy stated the critical importance of cultivating a skilled STEM workforce to address the complex challenges of national security and technological innovation.[5] As emerging technologies, such as artificial intelligence, quantum computing, and biotechnology, continue to redefine global competition, the U.S. Department of War (DoW) and the broader defense industrial base (DIB) face an urgent need to proactively recruit, train, and retain top STEM talent.[6] This entails fostering a pipeline of future innovators capable of leading the development and deployment of cutting-edge technologies that strengthen U.S. defense capabilities and maintain technological superiority.

The study examines the academic and professional backgrounds of personnel who have USG STEM leadership positions and assesses gaps that could hinder the effective management and regulation of emerging technologies. Among the identified individuals with publicly available profiles, only 41% of civilian government employees in STEM roles examined in this study possess formal STEM education, and 26% have prior STEM-related experience. These figures reflect potential vulnerabilities in the U.S. government's capacity to stay abreast of rapid technological advancements. While the dataset is limited to individuals with accessible online information, these findings offer valuable insights that could be indicative of broader trends across the civilian STEM workforce.

Serving in emerging technology fields requires more than traditional academic qualifications; it demands agility, a deep understanding of technology development, and the ability to navigate complex business and regulatory landscapes.

The research leverages data extracted from Leadership Connect[7] in 2024, which includes databases and analytic tools that track the career paths of government employees, providing a robust analysis of the intersection between educational background, professional experience, and STEM roles. This approach illuminates the urgent need for a workforce that is not only technically proficient but also adept in managing the dynamic nature of modern technology fields.

To bridge the gaps, it is imperative to enhance strategic alignment between qualifications and the demands of emerging technology roles.[8] This includes fostering a highly productive workforce by developing mentoring programs, deploying targeted recruitment strategies, and establishing policies that promote career progression in STEM.

The findings underscore the urgency of enhancing recruitment, training, and leadership strategies to help leaders in STEM fields make informed decisions, navigate complex technological landscapes, and effectively manage high-stakes innovation activities.

5 DoW. (2023). National Defense Science and Technology Strategy 2023. 1–12.

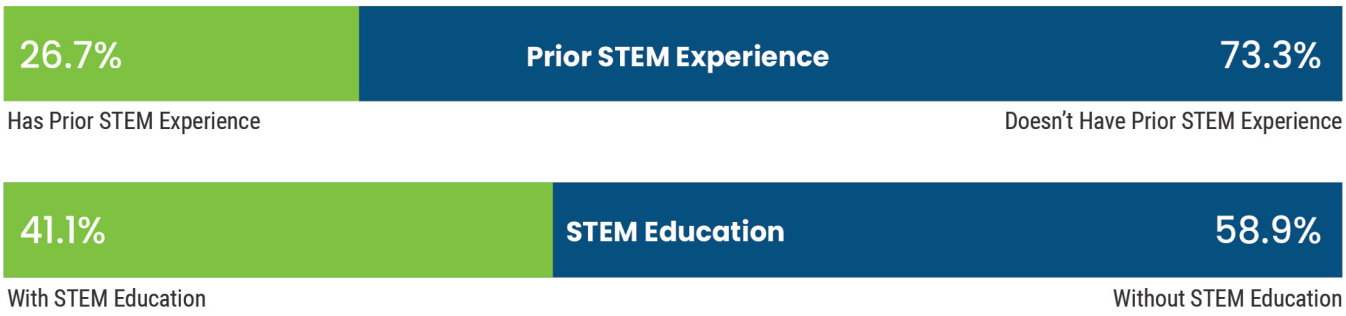
6 The State of U.S. Science and Engineering 2024 | NSF - National Science Foundation. https://ncses.nsf.gov/pubs/nsb20243/talent-u-s-and-global-stem-education-and-labor-force.

7 www.leadershipconnect.io

8 Howell, S. (2023). Technology Competition: A Battle for Brains | Center for a New American Security (en-US). https://www.cnas.org/publications/reports/technology-competition-a-battle-for-brains.

Key Findings

Figure 1: **STEM Roles in U.S. Government Emerging Technology Roles (excluding military personnel)**



The analysis of STEM roles across a set of USG civilian emerging technology positions reveals several key trends (Figure 1):

- A majority (58.9%) of individuals in these roles do not hold formal STEM degrees, suggesting that alternative pathways such as certifications, interdisciplinary training, networks, or work experience may be more prevalent entry routes, while 41.1% possess a formal STEM education
- 26.7% report prior professional STEM experience, indicating that most individuals transitioned from non-STEM fields into these roles

Gender disparities also persist, with men comprising 65.7% of the workforce and women representing 34.3%

STEM Education and Prior Experience Dynamics

Many individuals transitioned into STEM roles from non-STEM fields, which underscores the versatility and accessibility of these careers. While the dataset lacks detailed data on the specific non-STEM fields these professionals came from, it is clear that transferable skills from a variety of sectors, such as business, education, military service, or management, play a crucial role in such transitions. This adaptability not only widens the talent pool but also enriches the STEM fields with varied perspectives and skills. Future studies should aim to track these transition pathways more precisely to offer a clearer picture of how varied backgrounds and experiences contribute to success in STEM careers.

Correlation Between STEM Education and Experience

The Role of Formal Education:

41.1% of individuals in senior STEM roles hold formal STEM degrees (bachelor's, master's, or PhD), underscoring the traditional value placed on academic credentials in foundational disciplines such as engineering, data analysis, and biotechnology. However, since individuals with STEM degrees comprise a minority of the overall STEM workforce, it raises the question of "What types of educational backgrounds make up the majority?" Are senior STEM roles more often held by those with degrees in public policy, business, international affairs, or other fields? Understanding this distribution would offer more meaningful insight into the backgrounds most commonly associated with entry into and advancement within government STEM positions.[9]

Moreover, the majority (58.9%) do not possess formal STEM education, which highlights the prevalence and viability of non-traditional entry pathways—including certifications, cross-functional experience, and on-the-job learning—in enabling access to STEM careers within the USG. This potentially indicates shortages in the traditional STEM talent pipeline, reinforcing the need to recognize and support alternative routes into these critical roles.

In addition, further research is needed to understand how formal STEM education correlates with leadership attainment. Are individuals with STEM degrees more likely to hold leadership roles in certain subfields, such as cybersecurity or AI development, while others—such as technology policy or acquisition oversight—may draw more heavily from non-STEM disciplines? Identifying such patterns would help clarify which emerging technology roles truly require advanced technical education, and where alternative pathways are both viable and valuable.

9 For a comprehensive list of STEM-related opportunities and roles within the DoW, please refer to the Glossary.

Impact of Prior STEM Experience:

Only 26.7% of individuals in the dataset reported prior professional STEM experience, compared to 41.1% with formal STEM education. This gap may reflect the nature of the roles analyzed, which skew toward senior-level positions such as Program Director, Division Chief, and Senior Advisor. These roles often emphasize strategic oversight, Pentagon budget expertise, program management, or policy formulation. These are several areas where transferable skills and domain expertise can be more critical than direct technical experience.

Additionally, some positions may be classified as STEM, based on mission alignment rather than day-to-day technical demands. Without detailed data on job grade or technical complexity, it is difficult to assess how well prior experience aligns with current responsibilities. For example, junior employees (e.g., GS-9 to GS-13) are more likely to engage in hands-on technical tasks, while senior personnel typically operate at the programmatic or policy level. Future analyses that stratify roles by grade, function, and technical depth would offer clearer insight into how STEM backgrounds contribute to effectiveness in emerging technology leadership.

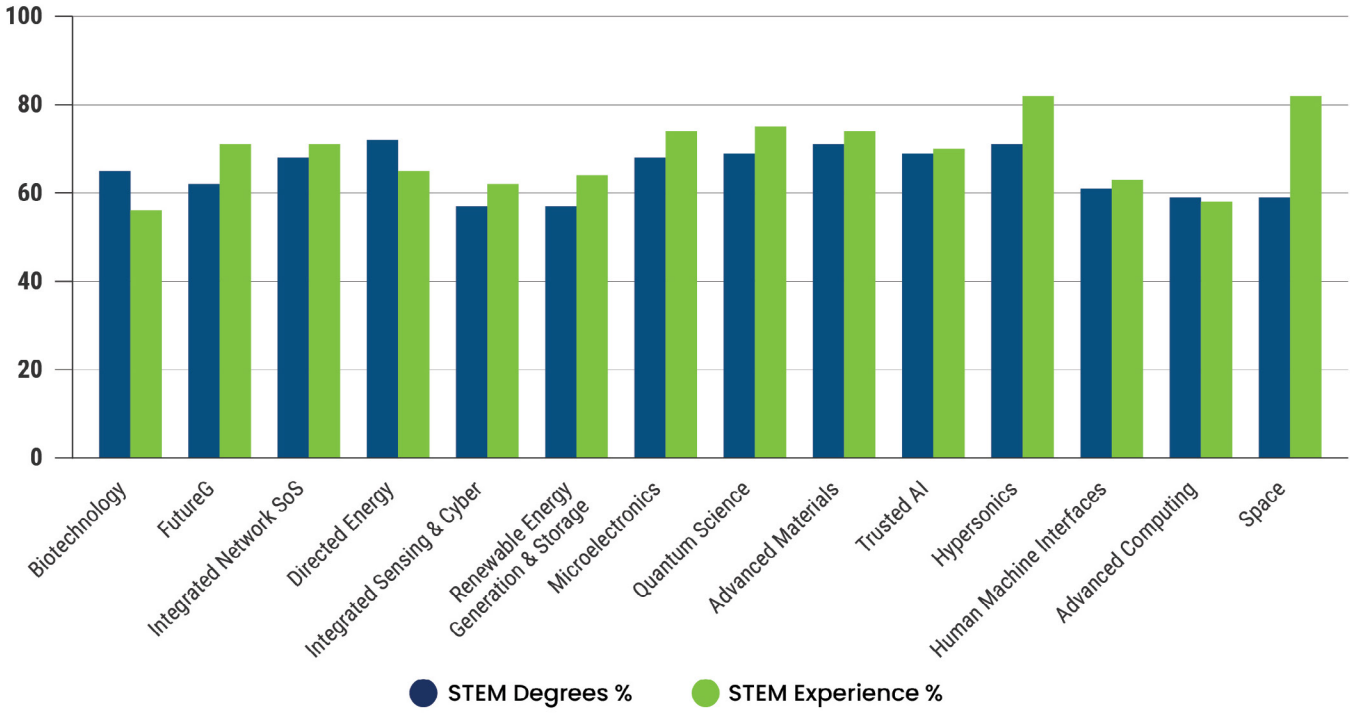
Organizational and Methodological Insights on STEM Workforce Analysis

The clustered bar chart in Figure 2 provides a detailed breakdown of the percentage of USG civilian employees with STEM degrees and prior STEM experience across various emerging technology fields. Notable observations from this analysis include the particularly high levels of prior STEM experience in fields such as Hypersonics (82%) and Space (82%), which contrast with a relatively lower representation in Advanced Computing (58%).

This analysis highlights the variability in STEM degree prevalence across key emerging technology fields, as illustrated in the accompanying chart (Figure 2). The combination of STEM degrees and experience levels elicits several hypotheses:

1. **Certain degrees may not have been available when current leadership was in school:**
   While artificial intelligence was founded as a discipline in the mid-1950s, people who entered the field typically came from a small set of adjacent academic disciplines that provided the mathematical or computational foundations needed for early AI research. Today, there are formal degrees in AI both at the undergraduate and graduate levels
2. **It is difficult to map the degree to the domain:**
   Many emerging fields, such as Integrated Sensing and Cyber, lack long-standing academic pipelines, which means that few senior leaders possess formal degrees in these areas. This also suggests that certain fields may be more interdisciplinary by design than others
3. **Practical experience may be prioritized over academic backgrounds in the selection process for leadership positions:**
   Fields such as Space and Hypersonics may require leaders to have broader competencies than the field's technical core

Figure 2: **STEM Degrees and STEM Experience Distribution for Emerging Technology Fields**



These fields were selected for discussion due to their prominence in emerging technology priorities and their variability in STEM degree prevalence, as shown in Figure 2. This variability underscores the broader trends and challenges in aligning educational backgrounds with the demands of critical STEM roles. This study also presents the opportunity to pursue deeper research into the data to either confirm or reject the three hypotheses presented above.

Transitioning into STEM from Non-STEM Backgrounds

Non-Traditional Pathways into STEM Roles:

The majority of professionals (73.3% of STEM role holders, or 2,234 individuals) in this dataset had no prior STEM-related experience, indicating an openness for individuals transitioning into the field from other sectors. This pattern suggests that many senior STEM roles value not only transferable skills such as problem-solving, project management, and analytical thinking, but also institutional knowledge, professional networks, and the ability to navigate bureaucratic or budgetary structures. These competencies, often developed outside traditional STEM environments, are increasingly recognized as critical to success in roles that blend technical understanding with organizational execution. Furthermore, the lack of detailed career histories for these individuals highlights a need for better data tracking to illuminate the industries or pathways from which they transitioned, how they progressed within STEM roles, and whether they reached leadership. Enhancing career history data, as outlined in Section 2, would help refine recruitment and workforce development strategies, ensuring that advancement is accessible across a range of backgrounds.

Leadership Roles Emphasize Soft Skills and Institutional Acumen:

In leadership roles, particularly in acquisition-related positions responsible for integrating and managing advanced technologies, soft skills such as strategic communication, team leadership, and stakeholder coordination sometimes outweigh technical depth. Moreover, success in these roles often hinges on the ability to mobilize organizational resources, navigate interagency dynamics, and leverage internal networks. For example, DoW civilian leaders are frequently promoted not solely for their technical knowledge, but for their capacity to align programs with mission objectives, manage complexity across silos, and steer efforts through bureaucratic processes.[10] This underscores a broader shift in emphasis from pure technical qualifications to the broader leadership attributes necessary to drive innovation and deliver results within the federal enterprise.

STEM Professional Experience as a Critical Factor:

Analysis of USG civilian roles shows that prior STEM experience varies by field, with Hypersonics and Space technology roles exhibiting the highest rates at 82%. This contrasts with fields like Biotechnology, where only 56% of individuals reported prior STEM experience, potentially reflecting different hiring patterns or developmental pathways. Rather than reiterating the overall importance of "hands-on" experience, a point established earlier, this disparity suggests that the value placed on prior experience may be sector-specific or that there is a shortage of individuals with relevant STEM experience in consideration for appointment to these positions. These variations underscore the importance of aligning recruitment and talent development strategies to the unique demands of each emerging technology field, ensuring that both educational background and applied experience are leveraged effectively.

10 The emphasis on leadership qualities in technical acquisition roles is supported by observations in workforce development literature and DoW civilian personnel policies that prioritize systems management, coordination, and strategic oversight over direct technical involvement (see Defense Acquisition University resources and related frameworks).

Consolidated Insights from Interviews on Key Findings

In response to the core findings outlined in the Key Findings section, a series of structured interviews were conducted with five current and former government employees occupying various roles within STEM offices. These participants were selected to represent a varied cross-section of educational backgrounds, demographic profiles, industry experiences, and career stages. The objective was to gather qualitative insights that would complement and deepen the quantitative analysis presented earlier, focusing on real-world experiences and personal perspectives regarding the challenges and opportunities in STEM government roles.

The Impact of Non-Traditional Pathways on STEM Career Development

Non-traditional pathways into STEM roles have become increasingly vital in a rapidly evolving job market, where the demand for broad and adaptable skill sets is high. One interviewee's experience serves as a testament to the role that non-traditional pathways play in the STEM field. "While I didn't start with a formal STEM degree, my experiences and on-the-job training provided me with unique insights that have proven invaluable," the interviewee noted. This narrative is not isolated; it reflects a broader trend where individuals leverage varied backgrounds to excel in technically demanding roles.

As discussed above, the data from our study underscores this phenomenon, showing that a substantial segment of the STEM workforce does not possess traditional STEM degrees. As one interviewee noted, “hands-on exposure” often compensates for the absence of formal academic credentials and supports effective job performance in real-world settings.

Furthermore, the success of non-traditional entrants into STEM highlights the need for more flexible hiring practices and educational programs that recognize the value of practical experience and soft skills alongside conventional degrees. By supporting pathways that accommodate varied educational and professional backgrounds, organizations can tap into a wider talent pool, enhance innovation, and foster a more adaptive and capability-driven workforce. Initiatives aimed at formalizing these pathways, such as certification programs tailored to specific technologies or apprenticeship models, can further help individuals entering STEM from non-traditional routes to be well prepared to meet the challenges of their roles. This approach not only addresses the immediate needs of the STEM sector but also sets a precedent for developing a resilient workforce capable of adapting to future technological shifts. Thus, enhancing the support for non-traditional pathways not only aids individuals in achieving their career goals but also strengthens the overall capacity of organizations to innovate and excel.

The Importance of Prior STEM Experience in Government Roles

The importance of prior STEM experience emerged as a recurring theme across the interviews, with several participants emphasizing how “hands-on” experience enhances effectiveness in technical government roles. As one interviewee noted, “Having a strong scientific background not only provides the necessary skills to address specific technical challenges but also fosters a methodical approach to problem-solving that is crucial in our field.” Another professional echoed this by stating, “The depth of understanding and the ’hands-on‘ skills gained from actual experience in STEM fields translate into more effective project management and innovation.” These perspectives are notable when contrasted with the study’s quantitative findings: Only 26.7% of individuals in STEM roles reported prior STEM experience, and just 41.1% held formal STEM degrees. While the interviewees’ views highlight the perceived value of technical backgrounds, the broader data suggest that many individuals succeed in these roles through non-traditional pathways—underscoring the variety of routes into STEM and pointing to the complex interplay between credentials, experience, and leadership effectiveness.

Further discussions revealed that professionals with substantial STEM experience tend to bring a strategic advantage to their roles. They are often able to anticipate technical challenges and address them more proactively, which can be pivotal in sectors where technological agility and innovation are critical. Additionally, such experience often includes a network of contacts and familiarity with the STEM community which can be leveraged to foster collaboration and spearhead initiatives more efficiently.

Fostering Continuous Professional Development in Government Roles

The imperative for continuous professional development in government roles, particularly those associated with STEM and emerging technologies, was a standout theme in the interviews. A leader in the field emphasized: "To remain effective and relevant in our fast-evolving technological landscape,

we must embed continuous learning into our operational ethos." This statement captures the critical need for government agencies to not only keep pace with technological advancements but also to ensure that personnel are constantly enhancing their skills and knowledge.

Continuous professional development within these roles involves a proactive approach to learning and adapting to new technologies, methodologies, and industry standards. It could include an organizational culture where ongoing training, workshops, seminars, and conferences are encouraged and seen as essential components of every employee's job, with a goal to enhance the overall capability of government agencies to respond to challenges and leverage opportunities in a timely and effective manner.

Furthermore, the establishment of robust professional development programs can serve as a strategic tool for attracting top talent and retaining skilled personnel. By demonstrating a commitment to the professional growth of its employees, government agencies may be able to enhance their attractiveness as employers and reduce turnover rates among high-performing personnel. This commitment must be supported by adequate resources and accessible learning opportunities that align with both the personal career goals of employees and the strategic objectives of the agency.

Enhancing Talent Management in Government STEM Roles

The enriched perspectives drawn from the interviews shed light on the intricate landscape of government roles in STEM and emphasize the urgent need for comprehensive strategies in talent management. The dialogue with industry professionals highlights the necessity for policies and practices that not only focus on attracting talent but also on retaining and nurturing this talent through proactive engagement and strategic career development. These insights underline the importance of creating a supportive environment that facilitates continuous learning and growth, which is crucial for retaining top talent and fostering a culture of innovation.

Implementing effective talent management strategies involves more than just recruitment; it requires a holistic approach to career development that addresses the unique needs and aspirations of individuals within the STEM fields. This includes providing ongoing training and professional development opportunities tailored to emerging technologies and the dynamic nature of these fields. Additionally, establishing mentorship programs that pair less experienced employees with seasoned professionals can enhance knowledge transfer and integration within the workforce. By investing in these areas, government agencies can enhance employee satisfaction and loyalty, which are key to sustaining innovation and maintaining a competitive edge in the global technology arena. This strategic focus on nurturing talent not only helps in retaining skilled professionals but also supports efforts to make sure the government remains adaptable and responsive to the fast-evolving technological landscape.

Recommendations

1. Enhanced Demographic Data Collection by DoW

A foundational step toward addressing STEM workforce challenges involves improving data accessibility and integration within DoW. While this research highlights key findings about STEM education, professional experience, and demographic trends, the analysis is limited by the lack of visibility into certain variables within the dataset used for this study. It is possible that some of this information, such as race, age, geographic location, and socioeconomic status, is already captured in DoW or broader USG databases but remains siloed or inaccessible for comprehensive analysis. DoW should consider developing a more integrated and accessible data framework to help make these critical variables available for future management initiatives. This would not only enhance the depth and rigor of future research and analyses but also help identify barriers and opportunities to strengthen the STEM talent pipeline.

2. Rethinking Educational Requirements for STEM Roles

Government and industry employers should reexamine rigid educational requirements for STEM roles to better align with the demands of emerging technology sectors without compromising rigor or technical excellence.[11] Our analysis revealed that only 41.1% of STEM leaders hold formal STEM degrees, while 26.7% have prior STEM-related professional experience. These findings imply a reliance on non-traditional pathways, such as certifications, technical training, or transferable skills from other industries, as critical sources of talent.

11 Goel, S. et al. (2023). Competence over Credentials: The Rise of Skills-Based Hiring | BCG. https://www.bcg.com/publications/2023/rise-of-skills-based-hiring.

This trend highlights that practical, "hands-on" experience is often valued as much as, if not more than, formal educational credentials in preparing individuals for the challenges of STEM roles.[12]

Emerging fields like cybersecurity, artificial intelligence, and advanced computing exemplify this shift. These roles frequently demand cutting-edge technical expertise and adaptability, qualities that can be more effectively demonstrated through professional experience, certifications, or on-the-job problem-solving rather than traditional academic pathways.[13] For example, individuals with experience in threat analysis or AI model training may possess critical skills that are not explicitly tied to holding a formal STEM degree but are essential for leading teams and addressing real-world challenges.[14] Similarly, the growing reliance on alternative pathways, such as retraining programs and on-the-job learning, reflects the need for a more flexible approach to hiring.

To address talent shortages in critical technology areas, the USG, particularly the DoW and civilian agencies involved in emerging technologies, should broaden its hiring criteria to prioritize demonstrated competencies over formal degrees. This shift would expand the candidate pool to include individuals with various skill sets, including those who may have faced barriers to pursuing traditional STEM education. Emphasizing alternative qualifications such as certifications, technical training, and relevant on-the-job experience would not only improve access and workforce agility but also reflect the realities of a rapidly evolving technological landscape. Moreover, this approach aligns with findings that individuals from non-traditional pathways often contribute innovative thinking and adaptive problem-solving, which are traits essential for success in high-demand, mission-critical roles across both DoW and the broader federal STEM enterprise.

3. Fostering Continuous Professional Development

Public sector organizations, especially those within the USG and DoW, should prioritize investments in continuous learning and professional development programs to maintain a workforce capable of navigating fast-evolving technology landscapes. In emerging fields such as artificial intelligence, cybersecurity, and quantum information science, offering advanced certifications and targeted training is essential.

While hiring external candidates with advanced certifications brings in fresh perspectives, particularly in areas where current expertise is lacking, equal or greater focus on upskilling existing employees is crucial. This approach fosters internal mobility and helps retain institutional knowledge, allowing organizations to promote from within and build employee loyalty. Structured pathways for professional growth, such as funding certifications and hosting workshops, not only prepare employees for higher roles but also boost job satisfaction and reduce turnover.

4. Targeted Recruitment Programs for STEM Professionals

Both the government and private sectors should initiate targeted recruitment campaigns specifically aimed at individuals with STEM education and experience. This underscores the importance of recruitment campaigns that target individuals with STEM education and experience, including those from non-traditional backgrounds. Such campaigns should aim to bridge gaps between formal education and practical experience.[15]

5. Strengthening Public-Private Partnerships

Enhancing collaboration between the government, private sector, and educational institutions is crucial.[16] These partnerships should focus on improving pathways for individuals with STEM experience to transition into government and industry roles. By investing in joint initiatives, such as mentoring programs or internships that target underrepresented demographics, the talent pipeline can be broadened and strengthened to include a wider range of skills, perspectives, and experiences.[17]

12 Gonzalez Ehlinger, E., & Stephany, F. (2023). Skills or Degree? The Rise of Skill-Based Hiring for AI and Green Jobs. arXiv preprint arXiv:2312.11942. Retrieved from https://arxiv.org/abs/2312.11942.

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14 The Wall Street Journal. (2023, May). Businesses, Government See Progress in Cyber Hiring, With Exceptions. Retrieved from https://www.wsj.com/articles/businesses-government-see-progress-in-cyber-hiring-with-exceptions-8683e90c.

15 West, D. (2023). ***Improving workforce development and STEM education to preserve America's innovation edge***. https://www.brookings.edu/articles/improving-workforce-development-and-stem-education-to-preserve-americas-innovation-edge/.

16 Patrinos, H. (2023). Designing effective public-private partnerships in education. https://blogs.worldbank.org/en/education/designing-effective-public-private-partnerships-education.

17 Lundy, K., & Ladd, H. (2020). Why collaboration is key to the future of higher education | EY - Global. https://www.ey.com/en_gl/insights/strategy/strategies-for-collaborating-in-a-new-era-for-higher-education.

6. Expanding the Pool of Potential STEM Employees

To increase the pool of potential STEM employees for DoW and USG more broadly, attention must also be given to underrepresented geographic regions within the U.S. that historically have had limited access to robust STEM recruitment pipelines and opportunities.[18] These areas often lack the infrastructure, funding, or proximity to large research hubs that are crucial for fostering STEM education and careers. This geographic disparity could impact the ability to recruit and retain talent from these states, further widening the gap in STEM representation nationwide. Strengthening initiatives like the Defense Established Program to Stimulate Competitive Research (DEPSCoR) is essential to address these regional imbalances.[19] DEPSCoR provides opportunities to states and territories that receive a disproportionately low level of federal research and development funding, helping to ensure a more equitable distribution of resources and opportunities in STEM-related fields.[20]

Minority-Serving Institutions (MSIs) can also play a crucial role in expanding representation of the STEM workforce. Institutions such as Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions (HSIs), Tribal Colleges and Universities (TCUs), and Asian American and Native American Pacific Islander–Serving Institutions (AANAPISIs) collectively enroll around 30% of all U.S. undergraduate students.[21] These institutions contribute to the STEM pipeline, with HBCUs alone graduating 25% of African American students with bachelor's degrees in STEM fields, despite representing just 3% of U.S. higher education institutions.[22] These individuals are generally also U.S. citizens and thus are eligible to obtain security clearances required to perform critical national security work.

Conclusion

The findings from the analysis highlight critical gaps and opportunities in the alignment of STEM education, prior experience, and demographic factors with the workforce's ability to fill and succeed in STEM roles, particularly within government and emerging technology sectors. Despite the growing emphasis on the importance of STEM skills in driving national security and economic competitiveness, the analysis shows that occupants of STEM leadership in government often do not have STEM degrees or prior experience.

Leadership Connect, as a platform, proves to be a powerful tool in understanding personnel and workforce talent management. Its ability to aggregate and analyze data on government personnel provides USG with an opportunity to become a smarter customer and regulator in fields such as Advanced Software, Space Technologies, and Microelectronics.

Ultimately, the data reveals that both formal STEM education and practical experience play important roles in shaping the government STEM workforce, though neither is universally present. The USG and private sector must modernize hiring practices, better leverage non-traditional educational backgrounds, and invest in scalable training and development initiatives. By addressing these challenges and utilizing platforms like Leadership Connect, the STEM workforce can be better positioned to drive innovation, enhance national competitiveness, and support efforts to maintain long-term leadership in emerging technology fields.

18 Taylor, D., & Arbeit, C. A. (2024). The STEM Labor Force: Scientists, Engineers, and Skilled Technical Workers | NSF - National Science Foundation. https://ncses.nsf.gov/pubs/nsb20245/conclusion.

19 Ibid.

20 U.S. Department of War. (2024). DoD Announces Defense Established Program to Stimulate Competitive Research Awards. https://www.war.gov/News/Releases/Release/Article/3711356/dod-announces-defense-established-program-to-stimulate-competitive-research-awa/

21 Fienberg, R. (2018). Minority-Serving Institutions and the STEM Workforce | American Astronomical Society. American Astronomical Society. https://aas.org/posts/news/2018/12/minority-serving-institutions-stem-workforce.

22 UNCF. The Numbers Don't Lie: HBCUs Are Changing the College Landscape - UNCF. (2024). UNCF. https://uncf.org/the-latest/the-numbers-dont-lie-hbcus-are-changing-the-college-landscape.

Appendix: Methodology

This study adopted a quantitative approach to explore the alignment between STEM qualifications and career outcomes, particularly focusing on STEM roles within USG agencies and emerging technology sectors. Using data extracted from Leadership Connect in 2024, a comprehensive database providing detailed profiles of a large proportion of senior-level USG officials, the research analyzed variables such as education, professional experience, and demographic attributes such as gender. To provide deeper insight into the experiences of individuals in these roles, the study also included five interviews with current and former senior government officials from various emerging technology fields.

To enhance the study's validity and mitigate the limitations of incomplete records, we employed multiple imputation techniques and manual verification methods to address missing data. Gaps in career history, educational background, and role assignments were supplemented using triangulation methods, including public data sources such as Google, USAJobs, and professional networking platforms. This process allowed for greater accuracy and robustness in constructing the dataset. The final analysis focused on evaluating the presence of STEM qualifications—specifically STEM education, prior STEM-related experience—and gender among USG civilian employees occupying STEM-designated roles. These variables were selected for their policy relevance and availability through the Leadership Connect platform, serving as the basis for regression analysis and statistical modeling.

While the study initially focused on the 14 critical emerging technology areas identified by the DoW, it was subsequently expanded to include a wider range of STEM-designated roles across additional technology subfields and government domains.[23] This expansion encompassed roles beyond the original USW(R&E) list, such as positions in broader scientific, engineering, and cybersecurity domains across civilian agencies. The rationale for this strategic broadening was twofold: first, to address data sparsity and limitations within the original sample of DoW civilian officials working in critical areas; and second, to generate a more comprehensive and statistically robust dataset that could support deeper analysis of government-wide STEM workforce trends. This broader scope improved the reliability of the findings and aligned more closely with the study's goal of identifying systemic trends in STEM qualifications, workforce composition, and leadership representation across the federal government.[24] Nonetheless, additional targeted research is still required to more fully assess the workforce dynamics within the original 14 critical technology areas, where specific gaps in qualifications and domain-specific expertise remain most consequential for national security priorities.

Data Collection

The primary data for this study was gathered from a variety of sources, including Leadership Connect, LinkedIn profiles, Facebook, and USAJobs. These data sources were selected due to their extensive coverage of government officials and STEM professionals in both public and private sectors. Demographic information, such as gender, and career histories was also extracted where available to examine individuals holding these roles.

This study draws on data from a wide range of civilian agencies and federal bodies actively involved in science and technology policy, research, and innovation. Key entities include the DoW, specifically the Office of the Secretary of War (OSW), Defense Advanced Research Projects Agency (DARPA), Defense Innovation Unit (DIU), Chief Digital and Artificial Intelligence Office (CDAO, formerly the JAIC), service-level laboratories such as the Army Research Laboratory and Air Force Research Laboratory, as well as select combatant commands and cross-functional teams.

Other agencies examined include the Department of Homeland Security (DHS), notably the Cybersecurity and Infrastructure Security Agency (CISA) and the Science and Technology Directorate; the Department of Commerce's (DOC) National Institute of Standards and Technology (NIST) and Bureau of Industry and Security (BIS); and the Department of Energy (DOE), including its Office of Science and major National Laboratories including Sandia, Lawrence Livermore, and Oak Ridge. Additional federal organizations include the Department of State (DOS) through its Bureau of Cyberspace and Digital Policy and Science and Technology Adviser's Office, and the Department of Health and Human Services (HHS), specifically the Biomedical Advanced Research and Development Authority (BARDA) and the National Institutes of Health (NIH).

23 STEM roles include but are not limited to: Chief Innovation Officer, Research Director, Director of Intelligence, Information Technology Manager, Chief Engineer, Chief Data Officer, etc.

24 STEM roles refer to positions that involve expertise or responsibilities in Science, Technology, Engineering, and Mathematics, including leadership and technical roles in fields such as data analysis, engineering, research, software development, and emerging technology sectors such as Artificial Intelligence, Quantum Computing, and Advanced Materials.

Table 2: **Leadership Connect Dataset Breakdown**

Sample Description	Sample Size (n)	Details
STEM Role Sample	3,047[25]	Subset of individuals identified as holding STEM-related roles within the USG.[26]
STEM Education	1,252	Individuals in STEM roles with formal STEM education.
STEM Prior Experience	813	Individuals in STEM roles with prior STEM-related professional experience.
Male	2,002	Number of males in STEM roles.
Female	1,045	Number of females in STEM roles.

Civilian innovation entities such as the Department of Veterans Affairs (VA) Innovation offices, NASA, the National Science Foundation (NSF), and the General Services Administration's (GSA) Technology Transformation Services (TTS) and 18F also form part of the analytic cohort. Other White House and federal technology organizations, such as the U.S. Digital Service, the Federal Chief Technology Officer's Office, and the Office of Science and Technology Policy (OSTP), were included as well. Notably, classified or intelligence-focused agencies, including the National Security Agency (NSA), Defense Intelligence Agency (DIA), National Reconnaissance Office (NRO), and National Geospatial-Intelligence Agency (NGA), were not comprehensively analyzed due to limited public data availability.

Data Processing

The dataset was filtered to focus on officials in STEM-designated leadership roles specifically tied to critical emerging technologies outlined in the National Defense Science and Technology Strategy. These leadership-oriented STEM roles were distinguished from broader or general technical positions based on criteria such as job titles, executive responsibilities, and seniority levels as indicated in the Leadership Connect dataset. Examples of titles classified under STEM leadership roles include "Program Director," "Chief Scientist," "Division Chief," and "Senior Advisor." Individuals whose responsibilities involved overseeing technical teams, directing strategic R&D initiatives, or managing enterprise-level technology programs were also categorized as STEM leaders. This classification was refined through cross-referencing of job descriptions, publicly available biographical data, and organizational hierarchy to provide a consistent and accurate delineation between general technical roles and those requiring higher levels of technical authority, strategic impact, or organizational leadership.

Limitations

Data Availability and Completeness

The datasets used in this study are subject to limitations in terms of both completeness and coverage. Not all individuals disclose their full career history, educational background, or skills on publicly available platforms, which can lead to underreporting of qualifications. Additionally, some profiles may lack critical details—such as STEM certifications, informal experience, or non-traditional learning pathways—that are not easily captured through conventional resume formats. Furthermore, it is important to note that the Leadership Connect database, while extensive, may not include every individual currently serving in a STEM leadership role within the government or all relevant government STEM roles. This potential underrepresentation could affect the generalizability of the findings and suggests that conclusions drawn from the dataset may reflect trends among publicly visible or documented individuals, rather than the entire STEM leadership population.

By acknowledging these limitations, the research highlights areas for further study and refinement. Addressing these limitations in future research could provide a more comprehensive understanding of the qualifications required for leadership in emerging technology roles, particularly within the national security domain.

As highlighted in the methodology section, the key findings below are separated from the overall analysis due to the complexity of the dataset. Some of the missing data that could potentially expand the policy analyses include age, geographical location, and race. This gap limits our ability to draw extensive or definitive conclusions about these emerging technologies and their workforce demographics.

25 Initially, the dataset from Leadership Connect included 7,362 profiles categorized under STEM roles. After a detailed review to verify the actual involvement in STEM-specific activities, only 3,047 profiles were confirmed to meet the criteria for this study, ensuring that our analysis focused on individuals directly contributing to STEM fields.

26 This refers to individuals in qualifying roles, specifically those in STEM-related roles of leadership within the USG. To streamline references, this group will be referred to as "STEM roles" throughout the text.

Furthermore, the dataset leaves room for more depth in areas such as educational and experiential breakdowns by role, which could have provided a more nuanced understanding of the talent landscape in these critical fields.

Given these limitations, a more holistic analysis was undertaken, examining 3,047 STEM-designated government roles. This broader dataset allowed for a more accurate and complete analysis of the individuals occupying these roles and the qualifications they hold. The expanded focus provides a clearer picture of the factors that drive success in these roles, offering a stronger foundation for analysis.

STEM Experience Data

This study highlights the difference between possessing formal STEM education and acquiring direct STEM experience, yet it stops short of analyzing the specifics of that experience. Crucial details such as the depth of technical involvement and whether the experience was in practical engineering, project management, or theoretical research remain unexamined.

The analysis further notes a lack of comprehensive demographic data, including race, age, socioeconomic background, marital status, and geographic distribution, which are vital for a full exploration of workforce accessibility and mobility in STEM roles. For instance, intersecting STEM experience with demographic variables could reveal if certain groups are more likely to enter these fields through unconventional paths.

Focus on Formal Qualifications

While the study examines formal STEM education and experience, it does not account for alternative forms of technical expertise, such as self-taught skills, industry certifications, or practical experience gained through non-traditional pathways. Leaders may possess relevant technical skills that are not reflected in their formal education or job titles, potentially skewing the findings.

Generalizability Across Sectors

This study began with an initial focus on 14 critical emerging technology areas identified by the DoW but was subsequently expanded to include a broader set of government roles across the emerging technology landscape. While the findings provide valuable insights into STEM roles within this context, they may not be directly applicable to other sectors, such as private industry or academia, where the dynamics of leadership and the emphasis on STEM credentials may differ.

Moreover, the study does not extensively explore roles within the uniformed military or across all USG entities beyond those explicitly tied to national security and emerging technologies. While the dataset includes a range of civilian agencies, it may not capture all components of the DoW, such as the National Security Agency (NSA), Defense Intelligence Agency (DIA), National Geospatial-Intelligence Agency (NGA), or other elements of the Intelligence Community, due to limitations in publicly available data. Uniformed military roles also follow distinct leadership structures and training pathways, which may yield different patterns of career development and STEM engagement. Similarly, agencies such as NASA, the Department of Energy, and others may prioritize different technical competencies based on their unique missions. A full list of the civilian agencies and components included in the analysis is provided in the Appendix for transparency and reference.

Expanding the scope of future research beyond DoW civilians to include military personnel and other federal agencies would offer a broader understanding of how STEM credentials and leadership qualities intersect across various governmental contexts. This could help identify sector-specific trends and best practices while enhancing the generalizability of the findings across a wider range of public sector roles. Additionally, comparative analyses between the government, military, private industry, and academia could shed light on how different sectors prioritize STEM qualifications and leadership development, further enriching the understanding of workforce dynamics in STEM fields.

Other Demographic Considerations

While gender was included in the analysis, other demographic factors—such as race, ethnicity, socioeconomic background, and geographic origin—were not assessed in detail. These attributes can shape career pathways and access to advancement, but limitations in the underlying dataset constrained deeper exploration. Accordingly, this study emphasizes observable patterns in education and career experience, while acknowledging that a more complete understanding of workforce dynamics may require broader data inputs in future research.

Potential Bias in Self-Reported Data

Much of the data in this study comes from self-reported platforms like LinkedIn and 3rd party aggregator software companies such as Leadership Connect, which may introduce bias. Individuals may embellish or omit certain aspects of their educational or career backgrounds, leading to discrepancies between reported and actual qualifications.

Glossary

STEM Role: A job or role that specifically requires expertise in science, technology, engineering, or mathematics disciplines, as outlined in both the job description and hiring requirements. The job description for such roles typically details duties that involve research, development, application, or oversight of STEM-related technologies, methodologies, or policies. Concurrently, the hiring requirements for these roles usually specify necessary educational degrees in relevant STEM fields or professional certifications that validate proficiency in specific technologies or methodologies. Additionally, demonstrated experience in specific technical areas such as artificial intelligence, cybersecurity, quantum computing, or biotechnology is often required. This combined approach was used so that roles are appropriately classified as STEM roles, aligning job demands with the qualifications and expertise needed for effective performance and contribution to national innovation and security.

STEM Education: Formal academic training in STEM-related fields, typically indicated by a bachelor's, master's, or doctoral degree in science, technology, engineering, or mathematics disciplines.

Prior STEM Experience: Professional or work experience in STEM-related fields prior to the current role, involving practical applications of STEM knowledge such as research, development, engineering, or data science.

Gender: Gender is represented as a binary variable in the dataset, with "Male" coded as 1 and "Female" coded as 0. This reflects the gender demographics of individuals in STEM roles, as captured by the dataset.

Examples of STEM roles:

Engineering and Technology Development

- Aerospace Engineers
- Systems Engineers
- Software Developers and Engineers
- Mechanical Engineers
- Electronics Engineers

Scientific Research and Analysis

- Biologists and Biochemists
- Physicists and Chemists
- Data Scientists and Analysts
- Environmental Scientists
- Artificial Intelligence and Machine Learning Specialists

Cybersecurity and IT

- Cybersecurity Analysts
- Network Engineers
- IT Specialists
- Quantum Computing Specialists
- Cryptographers and Information Security Engineers

Space and Defense Technology

- Space Systems Engineers
- Satellite Operations Specialists
- Directed Energy Scientists
- Hypersonics Engineers

Energy and Environmental Sustainability

- Renewable Energy Engineers
- Environmental Engineers
- Energy Systems Analysts

Logistics and Operations Research

- Operations Research Analysts
- Logistics Systems Engineers
- Human-Machine Interface Specialists

Acquisition and Program Management (with STEM Requirements)

- Program Managers for Technical Systems
- Acquisition Specialists with STEM Backgrounds
- Technical Project Leads

This list illustrates the breadth of STEM-related opportunities within the DoW. These roles require a mix of formal STEM education, technical expertise, and practical experience, emphasizing the varied pathways individuals may take to enter and excel in these roles. For example, while an Aerospace Engineer may require a formal engineering degree, a Program Manager overseeing a technical system might succeed with leadership skills and practical experience in STEM-adjacent fields. Future analysis could further investigate how academic and experiential qualifications align with the specific requirements of these roles.

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