

## **A Framework to Facilitate Higher Educational Institutions Delivery of Data Science Microcredentials: A First-Hand Experience**

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# A Framework to Facilitate Higher Educational Institutions Delivery of Data Science Microcredentials— A First-Hand Experience

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## I. INTRODUCTION

Officers typically enter the military after completing a four-year college degree; enlisted service members can transition to officer positions through various pathways and earn a degree while serving to satisfy their Military Occupational Specialty (MOS). While military training and experience are valued they, does not always translate to a clear and straightforward career in civilian life after retirement or when servicemen (i.e., military personnel, soldiers, and officers) separate from the military; every year, about 2000,000 veterans leave the military. Over the next five to ten years, an increasing number of those 2000,000 people will become engaged in data science and machine learning, driven by their interests, skills, backgrounds, and changing business needs[26]. The reason for this is (a) Data science will drive every type of business, and (b) The Army on a continuous basis, will need skillful personnel ( data engineers, analysts and scientists ) to embrace its growth in emerging analytic capability[24][25][26].

Microcredentials (MC) have gained increasing popularity in recent years as a way to recognize and validate competencies quickly and effectively. MCs are shorter, more focused than traditional degrees, and are often delivered online, making them more accessible to a wider range of learners. Higher educational institutions (HEIs) (the terms HEIs, Institutes and Universities are used interchangeably in the paper) are increasingly recognizing the value of MCs as they offer an innovative and flexible way to address the needs of a rapidly changing workforce. MCs are particularly well-suited for veterans and soldiers, who often have valuable skills and experiences but face challenges in translating these skills into civilian careers. By earning MCs, veterans can demonstrate their skills and knowledge to potential employers, increasing their employability and opening up new career opportunities.

The Work-in-Progress (WIP) focuses on the need to develop data science MCs for veterans, a high-demand area that is increasingly critical in today's data-driven world. The WIP recommends a design process for developing data science-related MCs for veterans, which includes identifying the skills, competencies needed, developing learning outcomes, designing assessments, and selecting appropriate delivery platforms.

The WIP also proposes a Microcredential Strategy Framework to facilitate building institutional capacity for microcredentials. The framework includes establishing core values, approval and administration processes, and selecting delivery platforms and content management systems that are appropriate for veterans. The proposed framework can be particularly useful for HEIs that do not have existing infrastructure for offering microcredentials.

The microcredential design process and proposed framework reported in the WIP is based on our first-hand experience in designing data-science related MCs for veterans in an institution with no existing practice or framework for managing microcredentials. The process and framework were developed through a combination of literature review, consultation with stakeholders, and feedback from veterans.

The proposed design process and framework have the potential to assist HEIs in creating and delivering MCs that meet the specific needs of veterans and other learners. While the WIP primarily focuses on the experience of veterans, the proposed framework can be adapted for designing, managing, and implementing microcredentials in general. As we report on a work in progress, future research can build upon this work by investigating the effectiveness of MCs in enhancing the employability and skills of veterans and other learners, as well as identifying best practices for designing and delivering MCs in different contexts.

## **II. RELATED WORK**

There are several challenges associated with microcredentials in computer science. These include the need for standardization and recognition by employers, the difficulty in verifying the quality and validity of microcredentials, the challenge of creating effective assessments and evaluations. Additionally, there are concerns about the potential for microcredentials to create "badges" that are not truly indicative of mastery or competence. Many researchers have already emphasized the importance of technology in education and provided a theoretical foundation for the role of technology in the design of microcredentials in computer science. For example, Lamb and Beck [1](2017) highlighted the benefits and challenges of microcredentials and provided a foundation for considering best practices in the design of microcredentials, especially for computer science.

McGivney-Burelle et al. [2] provide a comprehensive review of the literature on microcredentials in higher education. The authors synthesize previous research and discuss best practices for microcredential design, making it relevant to the design of microcredentials in computer science. The authors' findings suggest that careful design and implementation of microcredentials can result in significant benefits for students.

Koehler and Mishra [3] provide a definition and explanation of Technological Pedagogical Content Knowledge (TPACK). By discussing TPACK, the authors provide a theoretical foundation for the importance of technology in education, making it relevant to the design and implementation of microcredentials in computer science.

Darling-Hammond [4] provides a review of teacher education around the world. The author discusses the challenges and opportunities associated with teacher education and provides insights into best practices, making it relevant to the design and implementation of microcredentials in computer science.

Jang et al. [5] provide evidence of the impact of microcredentials on student learning outcomes. The authors discuss the results of their research and provide insights into the benefits of microcredentials, making it a valuable reference for understanding the potential impact of microcredentials on education and training.

### III. THE NEED TO DEVELOP DATA SCIENCE MICROCREDENTIALS FOR VETERANS

There is no one answer to why data science microcredentials may work best for veterans compared to other microcredentials, as this will depend on a variety of factors, including the veteran's background, experience, and career goals. However, the review of related work provides potential reasons, based on the intuition and assessment of other researchers, why data science microcredentials may be particularly well-suited for veterans. These reasons include:

***High Demand For Data Science Skills:*** Data science is a rapidly growing field with high demand for skilled professionals. Microcredentials in data science can help veterans gain in-demand skills and improve their employability in this field.

***Relevance Of Military Experience:*** Many veterans have experience working with large amounts of data and complex systems, which can be relevant to a career in data science. For example,

- (a). *Logistics data* — tracking supplies, equipment, and personnel movements.
- (b). *Intelligence data* — collecting and analyzing intelligence data which often involves working with large amounts of data and using data analysis to uncover patterns and trends.
- (c). *Military operations data* — monitoring enemy movements, tracking the progress of missions, and analyzing battlefield data to support decision-making.
- (d). *Maintenance data* — tracking the maintenance and repair of equipment and conducting analytics on continuously harvested data to improve equipment reliability and reduce downtime.

All such experience can be valuable when transitioning into a career in data science, as it demonstrates a familiarity with large amounts of data and complex systems, which are skills that are in high demand in the industry. Microcredentials in data science can help veterans build upon their existing skills and experience to transition into a new career.

***Flexibility and Portability:*** Data Science Microcredentials are flexible, portable, and particularly important for veterans who need to move frequently due to military obligations. For example

- (a). *Career mobility*—Veterans may need to move frequently due to military obligations, and DS microcredentials allow them to demonstrate their skills and knowledge in a compact and portable format. This makes it easier for veterans to transition their skills and expertise to new locations and employment opportunities.
- (b). *Continuous learning*—Data Science Microcredentials allow veterans to continue learning and developing new data science skills throughout their careers, even when they cannot commit to a full degree program. This is important for veterans who may not have the time or resources to pursue a traditional Data Science, Analytics or Artificial Intelligence related degree program, but still want to stay current in their field.

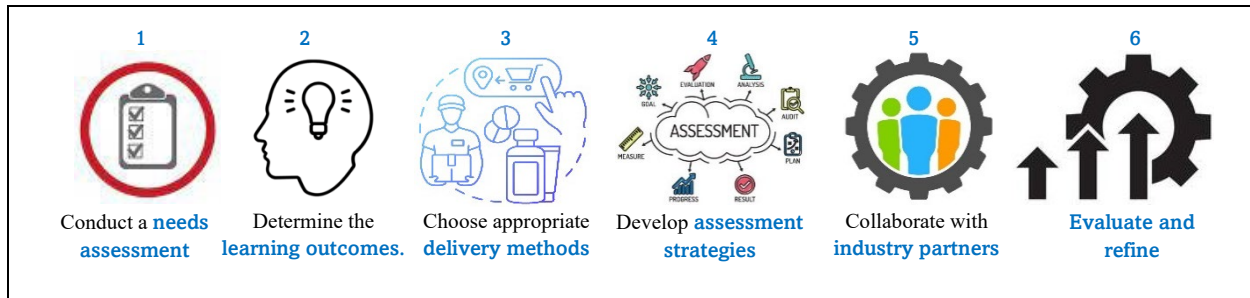


FIGURE 1: Design process of developing 'A' microcredential

- (c). *Career advancement*— Veterans can use microcredentials to demonstrate their skills, knowledge and progress in their careers, even if they do not have a traditional degree. This allows veterans to advance their careers and increase their earning potential.
- (d). *Specialization*— In the field of data science, a traditional degree is not always necessary to advance in a career. However, demonstrating one's skills and knowledge in the field is crucial for career progression. Microcredentials provide a way for veterans to demonstrate their skills and knowledge in data science, even if they do not have a traditional degree. This is particularly relevant for veterans who have military training and experience relevant to data science, but may not have had the opportunity to earn a traditional degree in the field. For example, veterans who have worked with large amounts of data and complex systems in the military can leverage their experience to demonstrate their skills and knowledge in data management and analysis, even if they do not have a traditional degree in data science. Additionally, microcredentials can allow veterans to specialize in specific areas of data science, such as machine learning, data visualization, or data management, and demonstrate their expertise in those areas.

**Career Advancement Opportunities:** Data science is a growing field with many opportunities for career advancement. Microcredentials in data science can help veterans demonstrate their skills and gain recognition in the industry, which can lead to new job opportunities and career growth. Moreover, Data science microcredentials can be earned online and do not require a full degree program, making it easier for veterans to fit education and training into their schedules.

While it may be true that creating a microcredential delivery platform or program may require some initial investment from educational institutions, there are several benefits that make it a worthwhile investment for both the institution and the student veterans. Firstly, offering microcredentials can attract a new market of veterans learners who may not have been interested in pursuing a traditional degree program. This can increase enrollment and revenue for the educational institution. Secondly, microcredentials can provide an opportunity for institutions to build relationships with industry partners and employers who may be interested in sponsoring or hiring veterans with data science skills or certifications. This can lead to increased funding and job opportunities for both the institution and the students. Lastly, by offering microcredentials, institutions can demonstrate their commitment to providing lifelong learning opportunities for their students. This can help build brand loyalty and reputation, which can lead to increased enrollment and revenue in the long run.

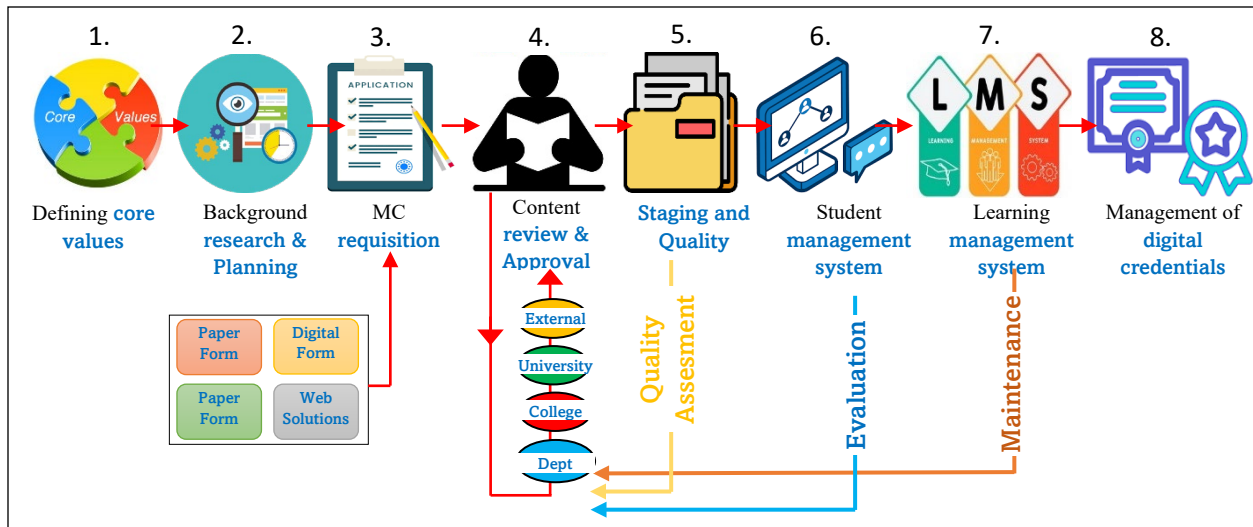


FIGURE 2: A Framework to facilitate building institutional capacity for microcredentials.

#### IV. THE DESIGN PROCESS FOR DEVELOPING DATA SCIENCE RELATED MICROCREDENTIALS FOR VETERANS

The design process for developing data science related microcredentials for veterans should take into consideration the unique needs and experiences of this population. The following steps in the microcredential design process can be exercised at the core-level, i.e., individual unit or department:

- 1) *Conduct a needs assessment*: Start by gathering information about the skills and knowledge veterans have acquired through their military experience and determine which of these are transferable to a career in data science.
- 2) *Determine the learning outcomes*: Define the specific skills and knowledge the microcredential should demonstrate. The learning outcomes should align with the demands of the data science industry.
- 3) *Choose appropriate delivery methods*: Consider the flexibility and portability needs of veterans when choosing delivery methods for microcredential. Online learning, blended learning, and experiential learning methods could be considered.
- 4) *Develop assessment strategies*: Create assessment strategies that effectively evaluate veterans' knowledge and skills. This could include hands-on projects, case studies, and real-world scenarios.
- 5) *Collaborate with industry partners*: Partner with industry experts, employers, and data science organizations to ensure that the microcredential aligns with the current demands of the field and meets the needs of employers.
- 6) *Evaluate and refine*: Regularly assess the effectiveness of the microcredential and make improvements as needed based on feedback from veterans, industry partners, and employers.

#### V. PROPOSED FRAMEWORK TO FACILITATE INSTITUTIONS DELIVER MICROCREDENTIALS TO VETERANS

Figure 2 provides a high-level architecture of our proposed framework, which HEIs can use to develop, package and distribute microcredentials to their targeted audience. The framework is

designed to be flexible and adaptable to the needs of different institutions and audiences (especially veterans), while also providing a structured approach to designing and delivering microcredentials. At the heart of the framework is a focus on identifying the skills and competencies that veterans need to succeed in the workforce and designing microcredentials that address these needs. The framework emphasizes the importance of working closely with veterans and other stakeholders to ensure that the microcredentials are relevant, accessible, and effective in meeting their needs. Below, we detail the steps of the proposed framework.

## **1. Defining Core Values**

The first step in offering microcredentials is to define an institution's core values, as it provides a clear direction and framework for the rest of the process. An institution's core values represent its fundamental beliefs, guiding principles, and standards of behavior. When designing microcredentials, these core values can serve as a guide to ensure that the microcredentials align with the institution's overall objectives and goals, and that they meet the needs of their target audience. By identifying core values, the institution can prioritize the skills and knowledge that are most important to them and their audience, and design microcredentials that reflect those priorities. For example, if an institution values innovation and cutting-edge technology, its microcredentials should reflect that by incorporating the latest trends and technologies in the field of data science. If the institution values hands-on, experiential learning, its microcredentials should include opportunities for learners to apply their knowledge and skills in real-world scenarios. Defining core values can also help to ensure consistency and coherence across different microcredentials offered by the institution. Without a clear understanding of the core values and mission of the institute, it can be difficult to design microcredentials that are relevant and effective for their intended audience.

## **2. Background Research & Planning (BRP)**

Before diving into creating the specific microcredentials, the second step for an institution/university is to do background research and planning to ensure that the microcredentials align with their core values and meet the needs of the veteran population. BRP facilitates the designing of microcredentials that are tailored to the unique needs and circumstances of veterans and align with the values and goals of the institution offering the microcredentials. This approach can increase the chances of success for both the veterans and the institution offering the microcredentials. This must involve:

- (a). *Conducting a needs assessment* of veterans interested in data science careers to determine what skills they need to acquire and which microcredentials would benefit them most. Various methods can be utilized, such as surveys, interviews, focus groups, and observation. Regardless of the method, the goal is to understand veterans' specific challenges and opportunities when transitioning to civilian life and pursuing careers in data science.
- (b). *Researching the job market for data science* and identifying in-demand skills and knowledge. This involves researching the current trends and projections in the local job market and identifying the types of positions that are currently in demand and likely to be in demand in the future. For example, around our institution trajectory in West Virginia

(according to the Bureau of Labor and Statistics), the top five industries are healthcare, retail trade, education services, mining and accommodation. Based on this, the institute can narrow the focus to data science applications in these industries and identify the required skills and knowledge. For example, in the healthcare industry, data science skills such as statistical analysis, data mining, and machine learning may be valuable for improving patient outcomes and reducing costs. In the mining industry, sensor data analysis, automation, and predictive maintenance skills may be in high demand. Similarly, The job market for data scientists in New York City is particularly robust in industries such as finance, healthcare, and media. These industries require skills and knowledge in high demand, such as data analysis, machine learning, statistical modeling, and programming languages like Python and R. By gaining a deeper understanding of the skills and knowledge that are in demand in the local job market, HEIs can design microcredentials that align with these needs. These microcredentials can then provide value for veterans seeking employment in and around the institute, university, or specific demographics.

- (c). *Analyzing the data science curricula at other universities* and programs to identify gaps or areas where the microcredentials could offer a unique value proposition to veterans.
- (d). *Evaluating the resources available at the HEI* to support microcredentials, including faculty expertise and technology infrastructure.
- (e). *Mapping out a plan for marketing and promoting the microcredentials* to veterans and relevant employers; a crucial and most important step to ensure the success of the program(s) offering MC to veterans. Rather than engaging digital marketing firms, institutions that develop and offer microcredentials should identify the most effective direct communication channels to reach employers and veterans. For example, reaching out to organizations and associations that serve veterans, such as Veterans of Foreign Wars (VFW), American Legion, Disabled American Veterans (DAV), Iraq and Afghanistan Veterans of America (IAVA), Student Veterans of America (SVA), Military Officers Association of America (MOAA), National Association of State Directors of Veterans Affairs (NASDVA), Veterans of Foreign Wars Foundation (VFWF), Wounded Warrior Project (WWP), and Veterans Affairs (VA), can help to increase awareness and credibility.

In addition to marketing, offering support services and resources to help veterans navigate the job market and connect with potential employers can increase the perceived value of the microcredential and improve its success rate. By providing these additional resources, institutions can enhance the reputation of their microcredentials, further highlighting the value and importance of the skills and knowledge veterans gain through the microcredential programs.

### **3. Microcredential Requisition(s)**

After the completion of BRP, the institutions must settle upon a process to initiate the development of micro-credentials. The requisition/initiation process may vary depending on the institution's policies and procedures. It can include various methods for faculty and departments to submit proposals for new microcredentials such as:



- *Paper forms:* Institutions can create paper forms that faculty and departments can fill out to propose new microcredentials. These forms can be submitted to a central office for review and approval.
- *Digital forms:* Institutions can also create digital forms such as Google forms[6], Type form [7], Survey Monkey [9] and Jotform [8] that can be filled out and submitted online. This can streamline the process and make it easier for faculty and departments to submit proposals.
- *Dynamic forms:* Some institutions use dynamic forms such as Wuffo[10], Adobe Experience Manager [11], Angular [12] and Nextgen Dynamic forms [13], that are customized based on the type of microcredential being proposed. These forms may ask different questions depending on the nature of the microcredential and the department proposing it.
- *Web-based platforms:* Institutions can also use web-based platforms that allow faculty and departments to propose and develop microcredentials in a collaborative environment. Such as Submittable [14] — cloud-based platform and Formstack [15]— a web-based platform. Both platforms allow organizations to create customizable submission forms (proposals) for microcredentials and provide features for collaboration and review.

Regardless of the method, the requisition should include all the necessary information to support all stakeholders involved in the content review and approval process. The MC Requisition should clearly and concisely describe the proposed microcredential, including the intended audience, learning objectives, and expected outcomes. At a minimum, it should include:

- Microcredential description, such as title, purpose, intended audience, learning outcomes or competencies that the microcredential aims to develop, course or module titles and descriptions, including any prerequisites or corequisites, assessment methods, including formative and summative assessments, and delivery format, such as online or in-person.
- A timeline for development and delivery and any necessary resources or funding required.
- An outline of the credentials and qualifications of the proposed instructors or faculty members who will be involved in developing and delivering the microcredential.
- Relevant industry standards or regulations that the microcredential will address and how it aligns with the institution's or department's goals and mission.
- Justification for why the microcredential is needed and how it will benefit learners and relevant industries or employers.

#### **4. Content Review & Approval (CRA)**

Once the MC Requisition is created, it must flow through the stakeholders for approval. One scheme for content review and approval is that institutions establish a dedicated task force, decoupled from any department or college, responsible for reviewing and approving proposals for new microcredentials. These groups can guide and support faculty and departments throughout the review and approval process, which can be iterative. The other and more systematic scheme is to have a content review and approval process at the department, college, and university levels, with varying granularity, depending on the institution's policies and procedures. However, a winning content review and approval process should include:

- (a). *Departmental Review*: Departmental review is essential to the microcredential development process. It provides a detailed assessment of the course content and ensures that it aligns with the department's mission and goals. The departmental review process involves thoroughly evaluating the course materials, learning outcomes, and assessment methods to ensure that they meet the department's standards for quality and relevance. The departmental review also helps to ensure that the microcredential fits within the department's curriculum and integrates with other courses and programs offered by the department. Additionally, the departmental review allows faculty members to collaborate, allowing them to share their expertise and contribute to the development of a high-quality microcredential.
- (b). *College Review*: College review is critical to ensure that the college can commit to the necessary resources and requirements needed for the microcredential course. This includes allocating funding for course development, instructor compensation, and ongoing support for the course. The review also provides an opportunity for collaboration among departments and cross-disciplinary input, allowing for a more well-rounded and comprehensive microcredential.
- (c). *Institutional Review*: Institutional or university-level review is the final step in the microcredential approval process. At this stage, the appropriate university-level committee or office, such as the Office of Academic Affairs, reviews the request to ensure that it adds value to the university's offerings, meets university-wide academic standards and policies, aligns with the university's mission and strategic plan, and fulfills the needs of students, employers, and the wider community. This rigorous review process ensures that the microcredential meets the highest academic quality and relevance standards, making it a valuable asset for the university and its stakeholders. The university-level review may also include a reassessment of the market demand for the proposed microcredential and its potential for success. The review may involve a panel of experts in the field, administrators, and other stakeholders within the university. This review aims to ensure that the microcredential aligns with the university's goals and objectives and meets the needs of students, employers, and the wider community.
- (d). *Content Review*: Departmental review is typically conducted by internal subject matter experts within the department who are familiar with the content and standards. However, external content reviewers can provide an additional layer of review and evaluation from an outside perspective. In the context of microcredential development for veterans, the involvement of external content reviewers can bring valuable perspectives and insights from professionals in the field who have experience working with veterans. They can ensure that the content is accurate, up-to-date, relevant, and applicable to the needs and experiences of veterans transitioning into civilian careers. External content reviewers can provide a level of credibility and validation to the microcredential, which can be important in gaining acceptance and recognition from potential employers. While departmental review can cover content review to some extent, external reviewers can bring a broader perspective and expertise that may not be available within the department.

- (e). *Approval*: If the proposal and content review process are successful, the microcredential is approved, and a notification is sent to the department/college, along with the timeline for producing the detailed course content and its delivery to the course design center.
- (f). *Evaluation*: The success of the microcredential is evaluated over time to assess its effectiveness in meeting the intended learning outcomes and meeting the target audience's needs.
- (g). *Maintenance*: After the microcredential is launched, it may undergo periodic reviews to ensure the content remains relevant and up-to-date.

## 5. Staging and Quality Assessment

After the microcredential proposal is approved, the department responsible for developing the course content begins working on the materials. In many cases, a collaboration platform such as SharePoint or Microsoft Teams is provided to the instructor(s) to facilitate the development process. Alternatively, cloud-based tools like Google Drive or Dropbox can also be used, despite them being more version control systems than collaborative environments. Once the course materials and content is developed, the staged contents are moved further down the pipeline to the institution's design center or quality assurance team to ensure that the microcredentials are of high quality, designed to support student learning and success, and meet established quality protocols such as *Quality Matters (QM)* [16] — faculty-centered, peer review process designed to certify the quality of online and blended courses; *eCampus Quality Instructional Design (eQID) Rubric* [17]— a framework for evaluating the quality of online courses based on a set of best practices in instructional design, pedagogy, and assessment; *Open SUNY Course Quality Review (OSCQR) Rubric* [18]— a tool for evaluating the quality of online courses based on a set of research-based best practices in course design and delivery. (b) Membership organizations that provide quality scorecard(s) to educators involved in online teaching and learning. Such as, *Online Learning Consortium (OLC) Quality Scorecard* [19] — a comprehensive tool for evaluating the quality of online courses based on research and best practices. It is imperative to ensure that the quality rubric is molded to keep the design needs of veterans in mind. Course materials should be designed to be accessible and easy to navigate, as some veterans may have disabilities or other challenges that make online learning more difficult. Quality aspects can include incorporating military-specific examples or case studies, using terminology familiar to veterans, or providing resources specific to their transition to civilian life. Once the quality of microcredentials is ensured, the course needs to be added to the institution's course offering catalog. Appropriate student management systems and learning management systems (also known as content management systems) must be sorted based on the targeted veterans' needs.

## 6. Student Management System (SMS)

Student Management Systems (SMS) can play a critical role in developing and delivering microcredentials designed for veterans. SMS is focused on managing student life's administrative and operational aspects, such as registration, enrollment, grading, billing, and student records. However, using an existing SMS in use by an institution may not be robust enough for managing

and delivering high-quality microcredentials to veterans. Several things need to be considered when selecting an SMS for veterans, such as:

- *Accessibility:* The SMS should be designed to be accessible to veterans with disabilities or other challenges that may make online learning more difficult. This could include features such as screen reader compatibility, keyboard navigation, and closed captioning.
- *Integration:* The SMS should be able to integrate with other systems that veterans may use, such as the Department of Veterans Affairs (VA) education portal or the GI Bill benefits system [20], to submit enrollment certifications to the VA for processing and billing of VA education benefits. Campus Management, Ellucian, and Workday are among the SMS that has features for billing the veteran. A public institution must consider an added layer or fee/payment processing by state-credible merchant(s) hence an SMS system that also provides integration with the state treasury office.
- *Data privacy and security:* Veterans may have unique privacy concerns related to their military service, so it is important to ensure that SMS meets high data privacy and security standards, particularly when dealing with veterans.

## **7. Learning Management System (LMS)**

Learning Management Systems (LMS), sometimes also called content management systems, primarily focus on managing the delivery of educational content, such as courses, assignments, and assessments. LMS is designed to facilitate the learning process, providing tools for organizing and delivering course materials, tracking student progress, and managing interactions between students and instructors. Nearly all institutions use some type of commercial LMS such as Blackboard, Moodle, and Edmodo or open-source LMS such as Chamilo, Open edX, and Canvas. Blackboard and Canvas are the most suitable for disseminating microcredential course content(s) to veterans since they offer advanced accessibility features that can benefit veterans with disabilities. At the time of our research, Blackboard is the only SMS that can be integrated with LMS and is much suited for veterans. Blackboard has a dedicated support team that can assist veterans with any technical issues they may encounter.

## **8. Management of Digital Credentials**

The management of digital credentials is a crucial final step in developing microcredentials, especially when considering veterans. Digital credentials provide a secure and accessible way to recognize the skills and competencies that veterans have acquired through their military service and civilian experiences. By issuing digital credentials, institutes can ensure that veterans have a portable and verifiable record of their achievements, which can help them demonstrate their skills to potential employers or academic institutions. Additionally, digital credentials can be shared on social media platforms, such as LinkedIn, providing veterans with a way to showcase their skills to a wider audience. However, institutes must ensure that the digital credentialing process is designed to meet the unique needs of veterans, such as making the credentials accessible and easy to navigate for individuals with disabilities or ensuring that the credentialing platform is compatible with the SMS used by veterans. Various platforms such as Credly [21], Accredible [22], and Badgr [23] offer features to institutes to customize badges based on their own criteria

and requirements. By carefully managing digital credentials, institutes can support the success of veterans as they transition to civilian life and pursue their career and education goals.

## **VI. Limitations and Future work**

The design process of microcredentials is based on our first-hand experience in an institute with no prior framework and offering of microcredentials. Our proposed design process is specific to developing and delivering microcredentials for veterans. It is important to note that the results may not be completely generalizable to other contexts or populations.

One of our work's main concerns/limitations is the potential for selection bias. The recommended CRA, LMS, and SMS were chosen based on systematic literature reviews, consultation with forums, and a few veterans' associations. While these sources provided valuable insights into the needs of veterans, they may not be representative of the diverse range of experiences and preferences within this community. Therefore, it is important to continuously evaluate the effectiveness of the chosen CRA, LMS, and SMS as part of our future work in accommodating the needs of all veterans under different conditions. This can be achieved through gathering feedback from a broader range of veterans and stakeholders and ongoing monitoring and analysis of usage data. By doing so, the process for designing and offering microcredentials can be continuously improved and refined to serve the needs of veterans better.

Although the paper proposes a design process for microcredentials, it does not yet report on our experience in designing microcredentials for veterans and mapping them to "stackable" microcredentials for course credit and data science degree programs. However, we plan to include this information in their future work, along with details on the dissemination procedure and evaluations of the microcredentials. Specifically, we will provide insights into the experience of designing data science microcredentials for veterans and how they can be effectively disseminated and evaluated to ensure their effectiveness. This will help to ensure that the design and offering of microcredentials continue to evolve and improve to meet the needs of veterans.

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