WIP: Case Study: Veterans SkillBridge Program for Hardware Security Workforce Development

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***Abstract*— This WIP research paper presents a qualitative thematic analysis of semi-structured interviews with participants in a Veterans SkillBridge program focused on hardware security, examining how veterans experienced the program and how their professional identities evolved as they transitioned to civilian careers. Developed in response to the growing demand for hardware security professionals and the unique potential of veterans transitioning into civilian careers, the program integrates cognitive apprenticeship principles to deliver hands-on, industry-informed training tailored to veterans. Based on data from the program's first cohort, the analysis reveals five key themes that emerged from participant interviews: (1) Mentorship and Guidance, highlighting the critical role of expert coaching and scaffolding; (2) Peer Support and Community of Practice underscoring the value of collaborative learning environments; (3) Sociology of Learning, emphasizing the impact of authentic, context-rich instruction; (4) Transferable Skills and Learning Curve, revealing how prior military experience intersected with new technical challenges; and (5) Emerging Professional Identity and Motivation , illustrating participants' personal growth and career aspirations. Findings suggest that real-world application, emotional support, and community-building are vital for effective training and successful veteran transitions. Nevertheless, the study also identifies gaps in scaffolding and foundational preparation, indicating areas for program improvement. Overall, this research offers actionable insights for designing vocational training that not only addresses workforce demands but also supports and empowers veterans in their post-service career development.**

Keywords—Hardware security, Veterans career transition, Cognitive apprenticeship theory

I. Introduction

In an era where cyber threats are growing more sophisticated, hardware security has emerged as a vital frontier in protecting embedded systems and critical infrastructure. Once considered inherently secure, hardware was long overlooked in cybersecurity strategies [1, 2]—a misconception that has contributed to a significant skills gap in the field. Today, the increasing complexity and globalization of technologies have introduced new vulnerabilities, heightening the urgency for well-trained professionals [3]. Addressing this challenge requires more than theoretical instruction; it demands immersive, hands-on learning that builds real technical proficiency [4]. Individuals who can perform reliably under pressure—such as military veterans— [5] have significant potential to excel in the field of hardware security. Now more than ever, we need practitioners equipped with both the knowledge and practical experience to secure the hardware foundations of our digital world.

To address the growing demand for skilled professionals in hardware security, we developed the Veterans SkillBridge through Industry-based Hardware Security Training and Education (VETS-HASTE) program. This initiative brings together academic and industry resources to deliver hands-on hardware security training tailored for veterans, who often possess strong technical foundations from military service in mechanics, electronics, and engineering. Unlike traditional classroom settings, VETS-HASTE integrates an industry-driven cognitive apprenticeship theory [6]. Through mentorship and real-world problem-solving, this training model not only prepares veterans for high-demand roles but also addresses the national shortage of hardware security experts, creating a dual impact on workforce development and veteran career advancement.

In this Work-In-Progress paper, we present a case study of the first cohort of the three-year VETS-HASTE program, which recruits a new cohort each year. The paper offers insights into veteran participants' perceptions of the training and their career transitions into the hardware security field. Specifically, we explore the question: How do veteran students describe their experiences with the VETS-HASTE program?

II. Context

This study draws on data from the VETS-HASTE program, a collaborative initiative aimed at supporting veterans in their career transition in hardware security. The program represents a partnership between a university, a non-profit organization dedicated to veterans' careers, and industry partners with expertise in hardware security. Designed with an emphasis on experiential learning, VETS-HASTE integrated the principles of cognitive apprenticeship theory [6] to facilitate deep, authentic skill development in a high-demand technical field.

The program's design incorporated the four dimensions of cognitive apprenticeship—Content, Method, Sequencing, and Sociology [7]. In terms of Content, participants engaged with core hardware security concepts such as buffer overflow, hardware Trojans, and side-channel attacks, using hands-on exercises and real-world problem-solving to build domain expertise. The Method dimension was particularly emphasized through expert modeling, coaching, and scaffolding, which was

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provided during office hours, webinars, and internships. Following the Sequencing, veterans progressed from basic knowledge acquisition to skill application through training and internship in hardware security. The Sociological dimension was also central, as veterans learned in a collaborative environment with peers who shared military backgrounds and aspirations for post-service technical careers. Real-world applications through internships and industry-driven coursework further situated learning in authentic contexts, enhancing relevance and motivation.

III. Methods

To achieve this goal, we conducted a 12-week industry-driven program on hardware security with ten veterans from May 6th to July 28th, 2024, followed by a 12-week internship ending on October 31st, 2024. Detailed descriptions of the program's design, along with the results of pre- and post-program surveys assessing participants' knowledge acquisition, self-efficacy, and engagement, are available in [8]. Following the completion of the VETS-HASTE program, all ten participants were invited to participate in follow-up interviews via email. Five individuals showed positive interest and were included in the study. Inclusion was based solely on voluntary interest, with no additional selection criteria. Ethical approval was obtained from University of Florida Institutional Review Board (IRB202301704), and all participants provided informed consent prior to their involvement in the research.

For the analysis, the researchers employed a qualitative thematic analysis approach following the six-phase framework established by [9]. Two independent researchers conducted the analysis to enhance methodological rigor and reliability. We used MAXQDA (Version 24) to organize data and support the coding process. First, both researchers independently familiarized themselves with the data through repeated reading of the transcripts. Second, the researchers generated initial codes using both deductive and inductive approaches. The deductive coding was guided by the cognitive apprenticeship theory [7] and existing literature on veterans' career transitions [10]. These frameworks provided structured lenses which allowed the researchers to analyze participants' experiences and identify relevant patterns within the established concepts. Concurrently, inductive coding was implemented through multiple iterative rounds to allow themes to emerge organically from the data itself. During this process, researchers deliberately sought to identify both semantic and latent codes. Semantic codes captured explicit, surface-level meanings expressed directly by participants, while latent codes revealed underlying assumptions, conceptualizations, and implicit meanings embedded within the data. This dual focus required researchers to engage in deep analytical reflection across multiple readings, continually refining the coding structure to capture both the overt and subtle elements present in the data.

Following the initial coding phase, the researchers individually searched for potential themes by examining relationships between codes and grouping similar codes together. The researchers then participated in iterative meetings to review these preliminary themes, discussing areas of convergence and divergence in their analyses. Through these collaborative sessions, the researchers refined and consolidated their findings into a set of convergent themes.

The final phases involved defining and naming these themes, ensuring they accurately represented the underlying data while providing meaningful insights related to the research questions. This collaborative approach in conducting the thematic analysis strengthened the validity of the findings through researcher triangulation while maintaining analytical depth and rigor throughout the process.

IV. Results

Through the thematic analysis, the veteran's experience with the VETS-HASTE program was organized into five themes 1) Mentorship and Guidance, 2) Peer Support and Community of Practice, 3) Sociology of Learning, 4) Transferable Skills and Learning Curve, and 5) Emerging Professional Identity and Motivation (see Table 1).

TABLE I. Thematic analysis of the VETS-HASTE program

Themes	Sub-themes
Mentorship and Guidance	Modeling Coaching Scaffolding
Peer Support and Community of Practice	Strong support network Sense of community
Sociology of Learning	Situated Learning
Transferable Skills and Learning Curve	Prior Experience and Transferable Skills A learning curve with foundational knowledge gaps
Emerging Professional Identity and Motivation	New motivations and identities Clarity in career direction

A. Mentorship and Guidance

This theme encompasses the hands-on guidance and support provided by program instructors and industry mentors, including expert demonstration of tasks (modeling), one-on-one assistance and feedback (coaching), and structured support to help participants' work (scaffolding). It highlights how participants learned from experts showing them how to perform tasks, helping them troubleshoot, and guiding their progress step-by-step.

Participants shared their experiences of modeling during the on-campus training, bi-weekly office hours, and the internship. One participant emphasized how much they absorbed by watching experts work:

"A lot of information was obtained from this course. We absorb a lot of information from the subject matter experts."

Furthermore, participants reported a clear example of coaching, where the expert not only showed the participant what to do but also provided insights to deepen the learner's understanding. Coaching was frequently observed in instances where the interviewees recalled their interaction with a mentor during the program, where the mentor provided practical guidance in both acquiring and applying technical skills. For example, one participant explained how an industry mentor personally walked him through new concepts:

"The mentor went out of his way to give me a better understanding ... we would get on Teams together, and he would

share information, and [he] would tell me how I could better myself in understanding of what was being done."

Another example of coaching was reported a participants' explanation of the hands-on project that was assigned to them during the internship period, and how the mentor instructed them through the step-by-step processes of the practical work.

"So that was what really interested in me, that it was both hands on, you got an opportunity to actually do the experiments work with somebody who's actually learning, was actually teaching, and I would be able to ask, and he would be able to relay it to me or explain it to me, or even show it to me"

Some participants wished for even more direct hard scaffolding. For instance, one veteran suggested they needed more live demonstrations of the hands-on experiments:

"It would have been nice to see more of that interaction. Like, 'Here's how you do experiment number five…we're going to go ahead and go through it.'"

Soft scaffolds, as well as hard scaffolds, were similarly emphasized by participants who were seeking timely intervention for closer academic and emotional support.

"They... I actually, anytime I had a problem, I can send a message, and somebody would reach back out to me within a few seconds … And it would give me little tidbits here and there for me to understand more of what I've already knew."

In the absence of such hard scaffolds, the participant felt they lacked a clear example to follow. These comments show that while mentors did provide substantial teaching and coaching, participants craved step-by-step instructions that are readily and easily accessible at any time. From this sense, the importance of providing timely scaffolds, both hard and soft, were emphasized in the interview.

"Oftentimes, we found ourselves just doing a lot of research on our own. We were just going online, doing research left and right. We learn, obviously, we you learn from that."

B. Peer Support and Community of Practice

This theme describes the strong support network and sense of community among the veteran participants. It includes how peers shared knowledge, encouraged each other, and collectively solved problems, creating a "community of practice" which is a critical characteristic of the cognitive apprenticeship theory. The dynamics of a strong support network and the organic interaction within such a network are also emphasized in veterans' career transition contexts [10] as a foundation for emotional stability and growth within the transition process.

The importance of having a strong support network was exemplified by the veteran's report of how they relied on one another for help and motivation, forming an informal support system during their transition. One participant highlighted the power of peer support, noting how shared experiences enriched their learning:

"The group of people that got selected to participate made it a great experience and facilitated my learning by providing examples and experiences while they were in the military service and even outside the years after they left the service."

Another veteran highlighted how having people who share similar backgrounds was invaluable in maintaining good morale and sustaining motivation throughout the program. Such experiences highlight the importance of establishing good support systems to ensure the learners maintain a good affective state.

"So whenever you had any questions, I'd always reach out to somebody else in our group to see if they understood it, or if they didn't understand it, or if I understood I would be able to share that knowledge with them. So that was good to have that group of people there with you that we're going through the same things."

"So being around all of those groups, everybody's telling me, and I'm actually working, and they're encouraging me. So it was very beneficial to me as far as that aspect as well, because it allowed me to gain that confidence that I felt like I lacked."

The community, which in this case are the other veterans from the cohort of this year's VETS-HASTE program, all shared a sense of goal, problem, concern, and a topic of interest. This collective purpose and their shared interest in learning made the community of practice perform more coherently, and productively.

"I went ahead and sent that out to everybody, 'Hey, there's this. You can go and get this hardware security certificate.'"

"All the veterans always kept on sharing information. If they found something, they were sharing information. 'Hey, look at this. This is a good place for bus snooping or fault injections,' or 'Watch this YouTube video on Verilog programming.' Or 'Here's something about C++.' Everybody was has been extremely professional and in that so I thank everybody for their time and effort and helping our veterans get a better understanding hardware security."

C. Sociology of Learning

This theme captures the importance of immersion in real-world or authentic learning environments for the veterans' learning. It reflects how learning in context, which is a core idea of situated learning, and experiencing the actual work environment helped participants feel included and enhanced their understanding.

Situated learning theory is one of the core sociological concepts emphasized in the cognitive apprenticeship theory. That is, the development of knowledge and the practical skills for its application takes place in real-world problem-solving settings and in social settings, rather than the pure acquisition of abstract concepts. Situated learning is exemplified by multiple moments in the veteran's experience of developing skills in engineering fields.

"We interacted with some individuals in the engineering department. So that was good, that interaction with individuals in the company working with the IT department, equipment that was given to us and software."

"I found very interesting is that you take your circuit board and you and your inventory each piece on the circuit board, and

you label the function and everything. But yeah, we had to label and then, and then also, to try to mimic it by creating your own circuit board on a on the on a diagram program. So you're getting more than enough experience."

Alongside situated learning, a sense of immersion also was reported to take place in the physical setting of a university campus. This quality of being in the moment to interact with peers and instructors was noted as being an important factor.

"Most veterans, we're old, so to say, just seeing everything and getting the interaction, and being able to follow along with the instructor right then and there. And if we have any questions or whatever, you know, we could raise our hand and say, 'Hey, can you come over and show us how you did that,' so on and so forth. So, yes, the whole face to face thing is a valuable asset."

D. Transferable Skills and Learning Curve

For many, transitioning to a career in hardware security offered an opportunity to reflect upon their prior experiences and explore whether the unfamiliar field of hardware security aligned with their professional interests and goals. The theme of Transferable Skills and Learning Curve highlights veterans' experiences of transitioning into a new domain (Prior Experience and Transferable Skills). This theme captures both the excitement of entering a new area and the challenges encountered while navigating the learning curve and gaps in foundational knowledge.

Some participants expressed a strong determination to become experts in hardware security. By connecting their previous career experiences, they indicated that they viewed the field of hardware security as their specialization.

"And this class actually helped me focus where I wanted to do an IT, what area I wanted to actually move in."

However, some participants feel limited in their ability to go beyond basic knowledge of hardware security. These learning curves sometimes led to feelings of being lost or struggling to keep up with the coursework and experiments.

"So basically, I'm still learning. Be honest with you, it is a very challenging field for the work, because it's been said by even the people that's just been doing hardware security, like you can't learn this stuff overnight."

Participants who joined without background skills felt the need for extra support. One suggestion was to provide more preparatory materials before or during the program: *"If we were given a group of terms to study… maybe read chapter one and two of [a] book… that gives you a better understanding."*

E. Emerging Professional Identity and Motivation

This theme describes how participation in the program contributed to the development of a new professional identity as well as their motivations for pursuing this new career path.

One participant, for example, described how exploring the field of hardware security led to the discovery of new motivations and professional identities. The participant shared that the program opened up a new career path in hardware security, and through the experience, was able to continue learning and gain the confidence to carry out small projects independently.

"It actually put me on the path of hardware security. It's actually something I'm seeking and learning, you know, till this day, I ended up building a remote, you know, for my television."

At the same time, veteran participants showed a strong desire to find a clear career direction in the field of hardware security. They thoughtfully considered how the skills gained through the program could translate into tangible employment opportunities.

"I'm hoping that I'll be able to take the knowledge and experience that I have there to hopefully get a job within hardware security I'm currently looking right now."

V. Discussion

Findings from this case study offer valuable insights into how this vocational training program supported veteran students in their career transitions. The thematic analysis revealed that not only the acquisition of new knowledge but also its utilization and application were essential for participants' career skill development. The experiences shared by veterans align with key principles of cognitive apprenticeship [7] and career transition theory [10], although several areas for improvement were also identified.

In line with [7]'s framework, participants emphasized the importance of modeling and coaching in their learning processes, particularly through interactions with instructors and peers. Peer-to-peer collaboration emerged as a significant factor that enhanced both learning and morale. Veterans actively shared resources, answered each other's questions, and tracked one another's progress, creating a strong sense of mutual support and community. This community of practice fostered a positive and engaged learning environment, reinforcing [10]'s and [11]'s view that social and emotional support is essential during career transitions. [12] similarly pointed out that social support is essential in helping veterans assimilate to the behavioral expectations and the workforce culture outside that of the military.

However, when viewed through the lens of cognitive apprenticeship theory, some elements—such as scaffolding, articulation, reflection, and exploration—were less visible or absent from the participants' experiences. This indicates potential gaps in instructional design. Or this gap might emerge due to the o difficulty of capturing the instructional design component from the learners' perspective alone. Thus, future studies need to incorporate instructors' perspectives to fully evaluate the program's implementation and effectiveness. Understanding how instructors approach or might better support these elements could lead to more comprehensive and balanced instructional practices.

Another challenge that surfaced was the variation in participants' foundational knowledge. While most had some relevant experience connected to hardware security from their prior careers, they still faced learning curves. This underscores the need to better accommodate learners with diverse backgrounds. Improvements in support materials—such as expanded glossaries, addition of foundational programming resources, and clearer scaffolding for complex topics—would

help reduce cognitive overload and ensure a smoother learning journey for all participants. For example, instructors can support veteran participants in understanding complex content by asking guiding questions that help them scaffold new information onto their existing knowledge.

The career transition of veterans within the civilian world has great implications regarding their mental, emotional, psychological, physical, and financial well-being [13]. Despite the potential tolls this transition process can take on various aspects of the lives of veterans, there is still a lack of research on how they perceive this transition process, and how professional training should be designed to support them. From this standpoint, this research contributes to bridging the gap by highlighting the lived experience of veterans in their active phase of career transition, and by providing rich descriptions of how they perceive their professional training program. The veterans' reports of their learning gains, and the change in their emotional, social, and psychological states throughout the program provide meaningful guidelines for how to design professional development and training programs that facilitate a smooth and successful transition into the civilian workforce.

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