INTEGRATING THREE-DIMENSIONAL MENTORING WITH WORKFORCE DEVELOPMENT TRAINING: A COLLABORATIVE AUTOETHNOGRAPHIC EXAMINATION OF SKILL TRANSFER

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ABSTRACT

The increasing demand for skilled professionals in technical fields necessitates innovative educational approaches that integrate skill development with effective mentoring frameworks. This paper presents an autoethnographic analysis of skill transfer within workforce development environments, emphasizing a three-dimensional mentoring model encompassing cognitive, emotional, and behavioral mentoring dimensions. The study examines applications in command-line learning, gamified instruction, and safety training within virtual environments. The research highlights best practices in mentoring sustainability, the role of technology in reinforcing skill acquisition, and the ways in which learning-community engagement enhances workforce readiness. Additionally, this study integrates research on student engagement, community experiences, and retention strategies, demonstrating how mentoring supports long-term learner success.

KEYWORDS

Mentoring, Online lab environment, Psychological safety, Cybersecurity skills gap, Workplace safety

1. INTRODUCTION

Workforce development programs are designed to enhance the employability of participants by equipping them with technical competencies and industry-relevant skills. Traditional instructional approaches often lack structured mentoring models necessary to sustain skill development and long-term skill retention. In adult education, teachers often take on the role of mentors, providing guidance and support that goes beyond traditional classroom instruction [1]. This mentorship approach is particularly effective for adult learners, as it addresses their unique needs. Research suggests that mentoring significantly impacts student retention and satisfaction, particularly in technical education environments[2], [3]. This study shares researchers experiences and successful classroom techniques applied to skill transfer within workforce development environments. The research explores how the three-dimensional mentoring framework—cognitive, emotional, and behavioral mentoring—contributes to effective skill acquisition, using case studies from command-line training, safety instruction, and gamified learning models, highlighting the commonalities found between domains.

We present two researcher's rich narratives regarding their lived classroom experiences. Darden's application focuses on introducing command-line interface (CLI) learning in a remote lab environment that incorporates gamified elements. This approach is a direct response to

DOI:10.5121/ijite.2025.14105

industry representatives who have identified CLI proficiency as a critical skill for cybersecurity and IT professionals. Pesina's contribution examines safety training in the classroom, emphasizing behavior-based feedback and software applications used to reinforce safety protocols. This study evaluates the effectiveness of mentoring frameworks in these learning environments, highlighting sustainable practices that enhance community engagement and workforce readiness[4].

2. LITERATURE REVIEW

Mentoring plays a crucial role in skill transfer and professional development[5]. Research by Hudson [6] and Korte [7] underscores the significance of structured mentoring in workforce development, emphasizing its impact on learner retention and long-term competency. The three-dimensional mentoring model, which integrates cognitive[8], emotional[9], and behavioral [10]mentoring, serves as a foundational framework for this study.

Safety training in workforce development environments often incorporates virtualization and digital assessment tools. Environmental and engineering safety researchers are increasingly turning to augmented reality systems and incorporating various forms of technology in the physical space in order to aid in programmatic engineering and industrial safety applications (e.g. [11], [12], [13], [14], [15], [16], [17]). Pesina'sexperiences examines how software applications, such asprogrammatic learning modules, facilitate mentoring-driven safety instruction in workplace settings.

While there is a wide array of research that has been completed on the cybersecurity workforce pipeline and skills gap (e.g. [18], [19], [20], [21], [22]), little has been done to address the idea of basic skills synthetization required to adequately build complex skillsets. The cybersecurity workforce frameworkaddresses skillsacquisition and transfer but does not discuss micro-skills required to be successful within the framework[18], [20], [23]. Organizations are expressing concerns about the skills that their employees are able to attain using traditional educational resources [21], [22]. Daniel, et. al [24] has called for an integration between practitioners who hold skilled knowledge and educators who design training solutions and also recognize that the skilled workforce is in continual need of upskilling as its demand outpaces supply, particularly considering advances in artificial intelligence [25].

Gamified learning has been shown to improve engagement and retention by reinforcing practical application through interactive experiences [26]. Carmi [27]highlights the role of mentoring in technical education, indicating that iterative and reflective mentoring models further enhance the sustainability of skill transfer with evidenced benefits in a variety of classical education domains (e.g. reading education [28], mathematics education [29], [30], [31], critical thinking, programming) and many other disciplines. With gamification, people learn intrinsically, as they solve some goal or generate some points. Capture-the-flag (CTF) gamification is routinely done in cybersecurity and information technology education to identify talent[32]. Therealso renewed emphasis on text-based games in the education space [29], [33], [34], [35]. The text-based environment is very close to simulating CLI operation of underlying technical systems in the information technology (IT) and computing systems space, including telecommunications and AI.Hardware and software often require mastery of a number of languages, interface programming systems, networking components, remote access and the troubleshooting and management of equipment and services require the almost constant use of a CLI environment.

3. THEORETICAL FRAMEWORK

The theoretical framework for this study is grounded in a three-dimensional mentoring model, which aligns technical skill development in a psychologically safe environment with cognitive, emotional, and behavioral feedback and mentoring support structures. Mentoring is a multifaceted process that can significantly impact personal and professional development [36]. Among the various approaches, cognitive, emotional, and behavioral mentoring models stand out for their distinct focus and methodologies, giving employees needed support in their skilling [1]. Cognitive mentoring ensures that instruction is tailored to the learner's background and industry requirements. Emotional mentoring fosters psychological safety, enabling learners to engage with complex technical concepts without fear of failure. Behavioral mentoring emphasizes the application of acquired skills in real-world scenarios, reinforcing retention through practical experience.

Cognitive, emotional, and behavioral mentoring models offer valuable frameworks for guiding mentees towards personal and professional growth while psychological safety is maintained. By understanding and applying these models, mentors can tailor their approach to meet the unique needs of each mentee, fostering growth and development across multiple dimensions.Feedback assessments and accountability loops can significantly improve mentoring experiences[1], [5].

Cognitive mentoring emphasizes the enhancement of cognitive skills such as critical thinking, problem-solving, and decision-making. This model is particularly effective in academic settings where the development of intellectual capabilities is paramount. For instance, the cognitive apprenticeship model, as discussed by Collins[8], involves teaching students the thought processes experts use to tackle complex tasks. This approach encourages mentees to reflect on their thought processes, challenge assumptions, and engage in activities like brainstorming and scenario analysis to stimulate cognitive growth.

Emotional mentoring focuses on the emotional development and well-being of the mentee. It aims to enhance emotional intelligence, self-awareness, and empathy. Emotional support in mentoring relationships has been shown to contribute significantly to mentee satisfaction and learning outcomes, as highlighted by Allen and Eby[9]. Mentors in this model provide guidance in managing emotions and developing resilience, often through reflective journaling and emotional regulation exercises.

Behavioral mentoring is centered on changing or reinforcing behaviors to achieve specific goals. This model is effective in environments where behavior change is necessary for success, such as leadership development or performance improvement. Behavioral coaching techniquescan improve goal attainment and mental health by using methods like goal setting, feedback, and reinforcement[10]. Role-playing and behavior modeling are commonly employed to practice new skills and reinforce positive habits.

These mentoring models can be integrated to provide a holistic mentoring experience, addressing cognitive, emotional, and behavioral aspects simultaneously. For example, a mentor might use cognitive strategies to enhance problem-solving, emotional techniques to build resilience, and behavioral methods to reinforce positive habits, creating a comprehensive development plan for the mentee.

Gamification serves as an auxiliary framework, supporting skill transfer through interactive engagement. Research by Venkatesh [37] demonstrates that gamified learning environments enhance motivation and reduce technology anxiety. This study applies gamification to command-line instruction and safety training, evaluating its impact on learner engagement and knowledge retention. Research-based teaching methodologies, including applying mentoring through feedback, create iterative learning opportunities that align well with mentoring frameworks, enhancing student competency over time [1].

Psychological safety is a crucial element in technical learning environments, significantly impacting skill development, knowledge transfer, feedback affectivity, and mentoring effectiveness with a particular significance in technical education contexts, enabling learners to engage more fully in complex tasks, ask questions without fear, and learn constructively from failures [38]. This is especially relevant in technology-focused settings, where rapid changes and system complexities can cause anxiety. Recent research by [39] and others has shown that psychological safety encourages experimental learning, idea sharing, and collaborative problem-solving in work teams. This research aligns with previous work demonstrating strong correlations between psychological safety and positive learning outcomes, especially in challenging, high-stakes environments [40].

The skills transfer process is an implicit part of the three-dimensional mentoring process. Mentees adapt their cogitates, emotes, and finally behaviors integrating new knowledge across skills application domains (e.g. Figure 1). Below we list the practical application specifics and how the skills transfer during the mentorship process.

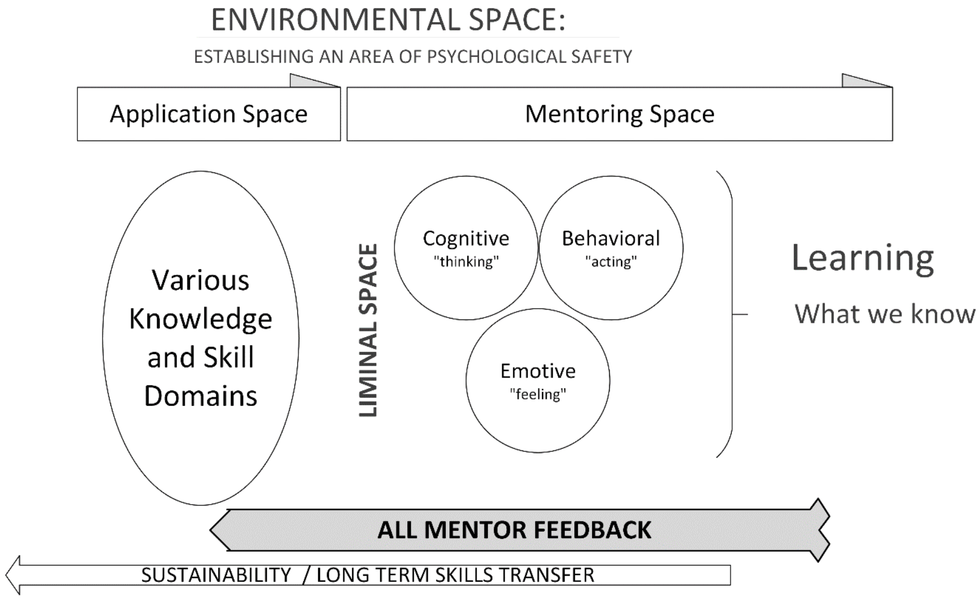

Figure 1. A psychologically safe environmental space is partitioned into a mentoring space and application domains. Learning, upon successful affectations of feedback, translate into sustainable skills through behavioral, cognitive and emotive integration in the liminal space between knowledge and skill domains.

4. METHODOLOGY

This work integrates data from two researchers' distinct expertise in technology education and mentorship. Their twelve-month collaboration, documented through weekly reflective sessions discussing technology use as educators,yielded rich narrative data on mentoring techniques in traditional and technology-enhanced learning environments. This data was analyzed to understand how diverse mentoring philosophies (cognitive, emotional, and behavioral) coalesced into a unified framework for technology education. The researchers' combined experiences in simulation-based learning and one-on-one mentorship provided a synergistic approach to understanding skill transfer and sustainable mentoring practices.

4.1. Research Design

Autoethnography, an empirical method blending self-analysis with systematic documentation, serves as the foundation for this study [41]. Through iterative dialogues and data collection, the researchers examined mentoring processes, refining their insights over time. The analysis followed Ngunjiri et al.'s[42]three-step approach—data collection, analysis, and reporting—alongside memoing techniques used by Lester et al.[43]that were used to note developing themes. This collaborative autoethnography explores the intersection of technology education and mentorship through the lived experiences of two participant-researchers. Over twelve months, weekly reflective sessions documented their approaches to mentoring in both traditional and technology-enhanced learning environments. The study employs narrative inquiry to examine how cognitive, emotional, and behavioral mentoring philosophies integrate into a unified framework for skill transfer and sustainable learning[44], [45], [46].

4.2. Participants

Darden, the first participant-researcher, brings extensive experience in cybersecurity education and simulation-based training, implementing scalable online learning environments in the classroom. He has taught cybersecurity and networking for the past six years, following 23 years in the telecommunications industry. Darden routinely encounters students who have a great desire to enter the cybersecurity workforce but are lacking skills or experience in direct technology use. Increasingly, students have mainly mobile device experience on social media sites—many not having any industry experience. It is common that students also lack experience in the process of interfacing with any type of programmatic environment.

Pesina, the second participant-researcher, brings extensive experience in education, environmental health and safety (EHS), and employee development. With over 20 years of expertise in workplace safety, compliance, and sustainability within Fortune 200 companies, he has led large-scale training initiatives, overseeing program administration for large organizations. Currently serving as an EHSS Global Director for a global manufacturer, he specializes in data-driven safety strategies and workforce development. As a doctoral student at The University of Texas at Tyler, his research focuses on teacher retention, mentoring programs, and career growth frameworks in human resource development. A published researcher, presenter, and mentor, Pesina is dedicated to advancing both organizational and personal development.

4.3. Group Dynamics of Research Team

The research collaboration emerged from the intersection of cybersecurity education and industrial safety training, revealing shared challenges in mentoring learners through complex technical concepts. This cross-disciplinary approach allowed the researchers to explore mentorship beyond domain-specific expertise, emphasizing relational feedback and the cognitive processes involved in skill acquisition.

By intentionally blending their perspectives, the researchers identified universal principles of technical mentorship applicable across fields. Their collaborative methodology created a space for shared reflection, highlighting how structured mentorship fosters both technical competency and psychological safety in learning environments.

4.4. Data Collection

Our research process centered on understanding how educators implement behavioral and cognitive mentoring techniques in technology-enhanced learning environments. Through routine and consistent interviews lasting roughly thirty to forty-five minutes each, we gathered rich narratives ofour significant experience bridging traditional and online learning spaces. The primary interview question prompted us to reflect deeply on our mentoring experiences: "Describe your experiences using technology and behavioral and cognitive mentoring techniques, whether in or out of a classroom environment, including establishing sustainability in the mentorship process."

The collaboration spanned roughly twelve months, during which we engaged in biweeklyreflective sessions discussing our approaches to technical skills development, mentorship methodologies, learning environment design, and student engagement strategies. We did not meet each week but were relatively consistent, meeting approximately 22 times between November 2023 and December 2024. Each interview was conducted via either video conferencing platforms or overthe telephone.Often,the virtual environment allowed for observation of non-verbal cues and immediate documentation of researcher impressions through detailed field notes using memoing techniques [43]. The interview process consisted mainly of discussing classroom behavior observed and techniques used and included reflective thoughts on how to bestadapt to challenges in the mentoring environment.

4.5. Analysis

Our interview sessions provided rich data for understanding how different mentoring philosophies could merge into a cohesive framework for technology education.This collaborative dynamic proved particularly valuable in identifying common patterns in how mentees and mentors develop and apply technical competency across domains, leading to insights about the universal aspects of technical mentorship.The collected narratives revealed compelling patterns in how mentors naturally integrate behavioral and cognitive approaches. Participants frequently described implementing graduated approaches, where they would begin with direct demonstration of technical skills before systematically reducing their intervention level as students developed competence. This progression was particularly evident in descriptions of simulation environments; mentors carefully balanced immediate technical guidance with broader strategic development.

4.6. Data Quality and Verification

To ensure the trustworthiness of our findings, we implemented a rigorous member-checking process.While we did not check after every interaction, there were several meetings dedicated to reviewing our notes collaboratively. This process added depth to our understanding of their mentoring experiences and ensured accurate representation of their practices, thereby enhancing the transparency and reliability of our research process.

4.7. Researcher’s Role

As participant-researchers in this study, our engagement transcended traditional boundaries of objective research, immersing us deeply in the mentoring environment we sought to understand. Our role evolved organically from observers to active participants in the creation and manipulation of mentoring spaces, both physical and virtual. Through this immersion, we experienced firsthand the complex dynamics of behavioral and cognitive mentoring while simultaneously analyzing and documenting these experiences.

The creation and management of mentoring spaces required constant attention to structure and flexibility. We found ourselves crafting and utilizing activities and environments where simulation and reality merged, designing scenarios that challenged traditional mentoring paradigms. In these spaces, we observed how learners navigated technical challenges while developing metacognitive strategies. Our presence as researcher-mentors influenced these interactions, shaping the learning experience while simultaneously studying its effects. Through this process, we discovered that effective mentoring environments require a balance between structured guidance and autonomous exploration. Our role as managers involved maintaining this balance while documenting its effects on learning and skill development. The complexity of our role as researcher-participants highlighted the interconnected nature of mentoring, feedback, and learning. Through our active engagement in the mentoring process, we gained a more profound understanding of how behavioral and cognitive approaches combine to create effective learning environments. This understanding emerged as we actually created and sustained these educational spaces: meaningful insights often arise from active participation in the phenomena being studied.

4.8. Validity and Reliability

The question of validity in qualitative research, particularly in autoethnographic collaboration, requires careful consideration of how researcher involvement shapes both data collection and interpretation. In our research process, we addressed validity through multiple layers of verification and reflection. The primary concern centered on ensuring that our personal experiences and interpretations accurately represented the broader phenomena of behavioral and cognitive mentoring. We demonstrated interpretive sufficiency and representational adequacy[47], attention to depth and breadth of mentoring relationships[45],and establishing an empirical foundation [48] of the technical aspects of skills transfer that our narratives captured. Our research process incorporated these principles through structured reflection sessions, detailed documentation of mentoring interactions, and systematic analysis of emerging patterns in our practice.

The collaborative nature of our work provided an additional layer of reliability, as each researcher's observations and interpretations were subject to examination and discussion by the other. The reliability of autoethnographic collaboration as an empirical method depends heavily on the researchers' ability to maintain systematic documentation while acknowledging and examining their own positionality within the research context[48]. Our approach to this challenge involved maintaining clear boundaries between observation and interpretation while also recognizing that these boundaries are necessarily permeable in autoethnographic work. This tension between objective documentation and subjective experience became a productive space for generating insights into the mentoring process. We considered it incumbent upon ourselves to correct each other during the interpretive process and assess whether we were narrating events or skippingto interpretive mode too soon. This was a beneficial practice as we grew familiar with each other as research instruments, including enhancing our ability to anticipate one another's interpretive nature.

4.9. Ethical Considerations

In our autoethnographic collaboration, ethical considerations centered primarily on protecting the integrity of the mentoring relationships we documented while maintaining transparency about our dual roles as researchers and participants. Although our research focused on our experiences as mentors and educators, we remained mindful that our narratives inevitably included interactions with learners and colleagues. To address this, we carefully anonymized all references to specific individuals or institutions in our field notes and final research documentation. Our reflection process focused on the broader patterns and principles of mentoring rather than specific incidents that might compromise the privacy of those we worked with during our professional practice.

The confidentiality of our data collection process was maintained through secure digital storage of all research materials.As researchers documenting our own lived experiences, we made conscious decisions about which aspects of our practice to share, ensuring that our disclosures served the research purpose while respecting professional boundaries. We regularly discussed and documented our ethical decision-making process, particularly regarding how to represent our experiences in ways that would contribute to the field's understanding of mentoring practices while protecting the trust inherent in mentoring relationships. This careful balance between transparency and confidentiality strengthened both the ethical foundation and the scholarly value of our research.

5. FINDINGS

This section presents the key insights derived from the study, focusing on the role of mentorship space in learning environments, the impact of simulation-based learning environments, and the effectiveness of skill transfer methods. These findings highlight how structured learning experiences, coupled with interactive engagement, contribute to the development of technical competencies and problem-solving abilities of adult learners.

5.1. Online Laboratory Integration for Cybersecurity Skills

Telehack [49], [50], accessed via web browser or over secure shell protocol, is an example of a fully immersive learning environment operating as both a sandbox and a user simulation in a remote lab environment. While other tools are scriptable for programmatic integration and designed to simulate specific command-line environments [35], the Telehack environment is gamified and designed to mimic a computer system from the early 1990s, connected to an early version of the internet. Darden stated, "*It's like going over to your friend Bobby's house in 1992 and sitting down at his Commodore 64 computer. Even the Motorola 6502 processor is emulated.*" With no graphical user interface, learners must navigate the system using simple commands. The simple commands translate into hands-on learning experience. This setting provides a forgiving space that encourages exploration and skill-building. Darden stated, *"Nothing looks familiar. That's part of the beauty of this environment. Initially it's an austere space, a disorienting space, but it becomes a comforting space."*

As Darden stated, "*My students need to know how to create a command. How to search for help on a system. We actually live in a world that is documentation-poor and information-rich. Where do you find help when you need it? They use simple commands on the system."*The simple commands are part of the interface itself, as commands were simpler in the past, but they also seem to reduce the cognitive load on the learner. Darden stated, "*I let them play, they can't screw anything up."*

The system's emphasis on command-line operations establishes a strong foundation for broader cybersecurity competencies. Mastering these fundamental tools in a structured environment enables learners to gain the confidence and capability to tackle real-world cybersecurity challenges. "*It's a world that doesn't exist anywhere today. Everything in real life is so complex and the gamified system is complex enough but there is a goal to achieve, something to drive for,* *a system that needs understanding applied to it.*" This seamless transfer of learning from simulation to application helps address the cybersecurity skills gap by producing practitioners with both theoretical understanding and practical experience.

> "*There is one program they run called porthack. It directly applies to a cybersecurity program we would use in real life, called Nmap, to scan for open ports. When students learn nmap they are surprised because it looks exactly like the porthack command in Telehack.*"

Through this structured approach to skills development, Telehack demonstrates how simulation-based learning environments effectively combine mentorship, practice, and community engagement to support the development of lasting cybersecurity skills. The environment has been employed by students both inside and outside the classroom. As learners navigate the text-based system in a dungeon-crawl-like manner, they gain hands-on experience with tools applicable to system administration and IT-related tasks. Darden stated,

> "*The use of Telehack was borne out of frustration that I sensed from mentees as students—they needed something extra. What they needed was a safe place to play. Telehack was this place. I could be a coach and mentor in the background while the simulation led the participant to a simple goal of gamified achievement."*

Mentoring within the Telehack system occurs as cybersecurity instructors guide students through command-line operations, scripting, and basic programming tasks. The system allows instructors to introduce gamification elements to a learner's pathway. While mentors oversee engagement with the environment, learners quickly discover an entire online community within the system. This real-time interaction with anonymous yet experienced users further support the social learning aspects of cybersecurity education.

5.2. Integration of Workplace Safety Training using VR and Emotional Support

Pesina's framework for workplace safety training emphasizes mentorship as a bridge between theoretical knowledge and hands-on skills, particularly through the use of Virtual Reality (VR) simulations in forklift safety training. He highlights the importance of structured learning combined with exploratory experiences, allowing trainees to develop problem-solving skills in real-world contexts. VR plays a key role in building confidence among trainees. Pesina noted, *"Trainees were told not to be nervous. If they could operate the forklift in VR, they could do it in real life. It seemed to calm them once I offered this guidance and encouragement."*

His model integrates emotional support into VR training, ensuring that failure is gamified rather than punitive. This approach reduces embarrassment associated with mistakes and fosters a mindset of learning and resilience. Pesina emphasizes that:

> *"workplace safety training benefits from both structured mentorship and hands-on, community-driven learning. VR serves as a bridge between theoretical instruction and real-world practice, allowing trainees to develop their skills in a safe, controlled environment."*

The immersive nature of VR-based forklift training helps trainees experience errors without real-life consequences, reinforcing skill retention and enhancing procedural safety awareness.

Dynamic mentorship is central to workplace safety training programs utilizing VR. Trainers act as mentors, offering emotional support, encouragement, and reassurance that VR training effectively prepares trainees for real-world scenarios. Pesina observed that

> *"when trainees realized that what they learned in VR directly translated to real-world operation, their uncertainty faded. They approached the training with more confidence, knowing mistakes were part of the learning process."*

The gamification of failure fosters a growth mindset, ensuring that mentees not only acquire technical competencies but also gain the confidence to apply their skills effectively in real-world settings.

6. DISCUSSION

The findings of this study highlight the critical role of structured mentorship in enhancing skill acquisition and learner retention. The integration of cognitive, behavioral, and emotive principles with technological simulation and spatial knowledge management has demonstrated a holistic approach to mentorship that integrates technical competency in a psychologically safe simulation environment. Structured mentoring provides not only technical guidance but also the emotional support necessary for learners to develop confidence and problem-solving skills.

Most skills programs look at the applications necessary to be successful [18] but these programs often fail to recognize methods to teach formative skillsets that prepare the learner for advancement in the learning space. Mentoring through the use of varied forms of feedback is utilized as skills are transferred from goals, thoughts, and then translated into repeated actions and finally conceptualized as learned experiences through integrative feedback [1].

Understanding cognition, and particularly situated cognition [51]provides a framework with which to view the lens of skills acquisition. Using this framework, thebehavioral change that is involved and made resilient through cogitative modeling is reinforced. Mentee-participants are not constrained to knowledge acquisition only but are able to focus on skill transfer as the number and quality of their action choices are increased in their learning environment. Their feedback-enforced skill set is developed because the action, action plane, and action system set are expanded for the participant-mentee. Situated cognition is present in the systems we describe as skill transfer is an actualization of expanded availability of new activities which can be planned, performed, and evaluated [51].

A particularly noteworthy finding is the function of social learning within the Telehack cybersecurity environment. By engaging with real-time, anonymous mentors embedded within the system, learners are guided through exploratory problem-solving experiences that enhance their cognitive and technical abilities. This informal yet structured peer mentorship model fosters resilienceby allowing participants to engage in a safe space where failure is gamified rather than penalized. This approach not only reinforces technical skills but also nurtures a growth mindset essential for continuous learning in rapidly evolving fields.

By utilizing a low-stakes environment built on the notion of a safe, or sandboxed, space, mentees engage in an enriching experience. The effectiveness of this approach lies in its integration of behavioral modeling with practical application. As learners observe experienced users, attempt commands themselves, and receive immediate feedback in a social environment, they develop both technical proficiency and problem-solving strategies. This process mirrors Bandura's social learning theory, where observation, imitation, and modeling play crucial roles in skill acquisition and development of self-efficacy [52].

Additionally, the psychological safety provided by anonymous mentoring networks has proven to be a critical element in fostering learner engagement. The ability to seek guidance without fear of embarrassment encourages participants to take risks and engage deeply with the learning material. As noted in existing literature, psychological safety plays a crucial role in learner motivation and persistence, particularly in complex skill acquisition scenarios[39]. By leveraging anonymity, mentorship communities create an inclusive learning environment where participants can build competencies without the constraints of traditional hierarchical learning structures.

These insights contribute to the broader discourse on mentorship by demonstrating that effective mentoring must be dynamic, adaptive, and inclusive to incorporate and create sustainability in the three-dimensional mentoring space (emotive, cognitive, and behavioral). The synthesis of traditional pedagogy with modern technological simulations presents a viable framework for scaling mentorship models across different domains. Moving forward, future research should explore the longitudinal impacts of mentorship-driven training programs, examining how sustained mentoring relationships influence long-term skill retention and professional growth.

7. IMPLICATIONS & FURTHER RESEARCH

This study demonstrates that structured mentoring, particularly through a three-dimensional approach, is a critical component of workforce development training. By integrating cognitive, emotional, and behavioral mentoring with gamified instruction and behavior-based mentoring feedback, skill transfer can be effectively reinforced in technical education settings. The findings contribute to the growing body of research on mentoring best practices, offering a replicable model for sustainable workforce development. The study highlights the importance of technology, training, and mentoring in fostering a competent, safety-conscious workforce prepared for industry challenges. Future research should examine the longitudinal impact of mentoring on career persistence, implications of AI in training environments, and continued sustainability of mentorship activities and community mentoring.

7.1. Limitations

While this study provides valuable insights into the role of mentoring in technical education and workforce development, several limitations must be acknowledged. This study is limited by the number of participants interviewed. While a qualitative study has no direct number of participants required [53] there is an underlying assumption that more participants would have provided more diverse reports ofmentoring experiences and skills transfer across a range of domains.

The study's reliance on qualitative data may limit its generalizability across different industries and educational settings. Although the collaborative autoethnographic approach offers deep insights into the mentoring process, the findings may not be universally applicable. The research primarily focused on simulated learning environments, which, while effective, may not fully capture the complexities of on-the-job mentoring in high-stakes situations. It should be noted that participantengagement was varied, and differences in prior technical knowledge may have influenced individual learning outcomes.

7.2. Future Research

Further research should incorporate larger sample sizes,including reviewer suggestions such as incorporating specific voices of mentee participants. Researchshould be conducted using quantitative methodologies to measure the long-term effects of mentoring interventions on skill retention, workplace engagement, performance, and career advancement. Additionally, future studies should explore the intersection of mentoring and emerging technologies such as artificial intelligence-driven training systems, virtual reality simulations, and immersive environments to enhance engagement and skill development in workforce training systems.

8. CONCLUSION

The integration of three-dimensional mentoring with CLI training offers a comprehensive approach to cybersecurity education. By addressing both technical and human aspects of learning, this framework enhances skill development, supports diverse learners, and contributes to closing the gender gap in STEM fields.

The findings of this study underscore the importance of structured mentoring in fostering skill acquisition, retention, and long-term career persistence. Through a combination of cognitive, emotional, and behavioral support, learners develop not only technical proficiency but also confidence and problem-solving skills essential for success in cybersecurity and other STEM disciplines. Additionally, the use of gamified instruction and behavior-based mentoring feedback demonstrates how interactive and immersive learning environments can drive engagement and reinforce skill transfer.

The implications of this study extend beyond cybersecurity education, offering valuable insights for workforce development across various technical fields. The mentoring framework presented here provides a replicable model that can be adapted to different learning contexts, ensuring that training programs remain dynamic, inclusive, and effective. By incorporating emerging technologies such as virtual reality simulations and AI-driven training systems, future educational approaches can further enhance engagement and personalized learning experiences.

As industries continue to evolve in response to technological advancements, the demand for highly skilled professionals will increase. This study highlights the role of mentorship in preparing a competent workforce capable of addressing complex industry challenges. Moving forward, continued research should explore the long-term impact of mentoring interventions on career progression, job performance, and knowledge retention. Furthermore, expanding mentorship programs to underserved communities can play a vital role in promoting diversity and inclusion within technical professions.

By fostering a culture of mentorship, collaboration, and continuous learning, educational institutions and organizations can create sustainable pathways for skill development and professional growth. The integration of structured mentoring with innovative training methodologies presents a powerful solution for equipping learners with the tools they need to excel in cybersecurity and beyond.

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