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Abstract

A growing number of academic institutions have invested resources to integrate cyber ranges for applying and developing cybersecurity-related knowledge and skills. Cyber range developers and administrators provided much of what is known about cyber range resources and possible educational applications; however, the educator provides valuable understanding of the cyber range resources they use, how they use them, what they value, and what they do not value. This study provides the cyber range user perspective of cyber ranges in cybersecurity education by describing how K-12 educators are motivated using cyber ranges. Using mixed methods, this study explored educator motivation associated with cyber range usage through the lens of Eccles' Situated Expectancy Value Theory. This research contributes to understanding how educators are motivated using academic cyber ranges for cybersecurity education. Overall, educators were motivated but professional development and preparation resources that do not assume any prior cybersecurity knowledge would contribute positively to their usage. Cybersecurity education stakeholders should continue to support cyber range integration to strengthen cybersecurity education programs and support educators' ability to become better cybersecurity educators.

Keywords

cybersecurity education, cyber ranges, educator motivation, situated expectancy value theory

A Mixed-Method Study Exploring Cyber Ranges and Educator Motivation

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***Abstract*— A growing number of academic institutions have invested resources to integrate cyber ranges for applying and developing cybersecurity-related knowledge and skills. Cyber range developers and administrators provided much of what is known about cyber range resources and possible educational applications; however, the educator provides valuable understanding of the cyber range resources they use, how they use them, what they value, and what they do not value. This study provides the cyber range user perspective of cyber ranges in cybersecurity education by describing how K-12 educators are motivated using cyber ranges. Using mixed methods, this study explored educator motivation associated with cyber range usage through the lens of Eccles' Situated Expectancy Value Theory. This research contributes to understanding how educators are motivated using academic cyber ranges for cybersecurity education. Overall, educators were motivated but professional development and preparation resources that do not assume any prior cybersecurity knowledge would contribute positively to cyber range usage. Cybersecurity education stakeholders should continue to support cyber range integration to strengthen cybersecurity education programs and support educators' ability to become better cybersecurity educators.**

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I. Introduction

Like the industrial age, the current digital age requires a level of technology literacy integrated into education to provide students with the necessary knowledge and understanding to use and develop technology to meet human needs and wants. Through technological innovations, the digital age includes a connectedness that promotes a level of global interaction and touches many aspects of our personal, social, and professional lives. However, our connectedness also causes the need for securing the digital space against threats to our personal identity and financial security. Most K-12 schools include technology education and online resources to support general education needs and standardized testing. However, access to online resources poses security challenges as many schools experience cyber-attacks and breaches [1]. Due to the shift many schools made to virtual learning during the COVID pandemic, the rise in remote learning that required students and teachers to interact online caused an escalation of cyber-attacks in the education sector [2].

Cybersecurity education is needed more now than ever as the computer user continues to be the weakest link in cybersecurity [3, 4]. Cyber attacks target students, parents, and teachers at greater levels due to the pandemic that forced many schools to operate virtually. The best defense is awareness training and understanding. However, formal cybersecurity education is not included in pre-service teacher preparation, and most current cybersecurity educators do not acquire knowledge until teaching [5].

Federal, state, and private efforts to support K-12 cybersecurity education include curriculum, enrichment activities, and professional development (PD) resources. These include Cyber.org, which partners with the Department of Homeland Security and the Virginia Cyber Range (VaCR) in Virginia, which also launched the U.S. Cyber Range in 2019 [6]. The VaCR, a collaborative effort of several higher education institutions, provides cybersecurity educational resources to support K-12 and higher education institutions. These resources include virtual labs, lessons, videos, workshops, and Capture the Flag (CTF) challenges to further cybersecurity knowledge, skills, and interest.

Educational cyber ranges provide a safe environment for students to practice cybersecurity-related skills without concern of compromising a school's existing network. It is a protected, simulated environment for realistic training. However, the use of educational cyber ranges is relatively new.

The purpose of this study was to explore how K-12 cybersecurity educator motivation is manifested through the lens of Eccles' Situated Expectancy Value Theory (SEVT) for Academic Motivation [7, 8] in the context of using cyber ranges for cybersecurity education. As more schools recognize the importance of cybersecurity education, they may invest in cyber ranges to support their programs. Exploring how current cybersecurity educators are motivated using cyber ranges provides understanding on how cyber ranges are valued or not valued by the educators who use them to provide cybersecurity education.

This study addressed the literature gap regarding cybersecurity educator motivation towards using cyber ranges for cybersecurity education from the K-12 educator's perspective. The research questions for this study were:

- How are cybersecurity educators motivated using a cyber range?
- Are there any significant motivation variations based on cybersecurity education teaching experience, instructional level, or gender?

This study explored how cybersecurity educators registered with the VaCR were motivated using the cyber range. Responses to an anchored open-ended (AOE) questionnaire were analyzed regarding expectancy of success and task values such as attainment, interest, utility, and relative costs. Results showed that educators were primarily motivated by the importance of using the VaCR for cybersecurity education, their interest in using a cyber range, and their confidence in their ability to use it. They were less motivated by the usefulness and the relative costs of using the cyber range. Significant variation in motivation was found only in interest in using cyber ranges for cybersecurity education by gender. Those who identified as females had less interest than those who identified as males.

II. Literature Review

Limited research exists that has examined the use of cyber ranges in cybersecurity education. Moreover, fewer studies explore K-12 cybersecurity education and cybersecurity educator motivation. Therefore, this study addressed a critical gap in cybersecurity education literature and is informed by existing literature.

A. Cybersecurity Education

Most studies focus on the higher education level and explore specific cybersecurity education approaches, including multidisciplinary content and lab activities that provide opportunities to use real-world tools to address real-world problems [9 – 11]. Other studies examined the approaches used to provide cybersecurity training to working professionals within organizations and government institutions. These studies also described the approaches the researchers used to provide cybersecurity training and shared the findings of their methods [12-14]. These studies recommended hands-on experiences to develop skills using a cyber range platform to provide emulated and simulated components.

A literature review conducted at Masaryk University examined the state of cybersecurity education as presented by two sub-groups of the Association for Computing Machinery (ACM), the Special Interest Group on Computer Science Education (SIGCSE), and the Innovation in Technology in Computer Science Education (ITiCSE), from 2010 to 2019 [15]. The review primarily served three groups, cybersecurity educators and managers, to inform them what cybersecurity topics were being taught and how they were taught. The second group was researchers to provide an overview of evaluation methods, recommendations, and ideas for further research. The third group was the SIGCSE/ITiCSE community to inform them of the work they have accepted and published regarding cybersecurity education over the last ten years. Like the other studies, most of the papers in the review described a course, hands-on exercise, or tool and evaluated its effect on student learning. The context was universities located in the United States. The review did not cite any studies of cybersecurity educator motivation.

B. Educator Motivation

Only one study was identified that examined educator motivation and cybersecurity education; a 2013 dissertation study addressed cybersecurity education for K-12 faculty and staff in Allegheny County of Pennsylvania [16]. The study made recommendations for motivating teachers, including adding security-related objectives in their annual performance review. The study provided an online learning approach to provide cybersecurity education to K-12 faculty and staff and evaluated the effectiveness of the training program. The training program focused on cybersecurity, cyber safety, and cyber ethics. The study recognized teacher resistance towards cybersecurity training and other challenges, including teachers not being prepared to teach cybersecurity topics.

These prior studies contributed toward understanding of the effectiveness of cyber ranges for hands-on learning in cybersecurity education in higher education [9-11] and in professional organizations [12-14]. These prior studies agreed that cyber ranges are effective for hands-on learning; however, they did not explore educator motivation using a cyber range for cybersecurity education. Younes' study [16] evaluated the effectiveness of a cybersecurity education program and included recommendations for motivating teachers who were resistant to cybersecurity training; however, the study did not explore why these educators were less motivated and resistant. Prior studies agree that teacher PD is needed but do not include recommendations informed by studies of teacher motivation. A recommendation by Younes [16] of adding security-related objectives to educators' performance review is made without insight into how these educators are motivated. This study explores educators' motivation and describes how they were motivated. Understanding educator motivation contributes towards recommendations that are research informed from the educators' perspective.

III. Theoretical Framework for Motivation

This study used Eccles' Situated Expectancy Value Theory (SEVT) as the theoretical framework for exploring educator motivation using cyber ranges for cybersecurity education. Eccles' SEVT theorizes academic motivation based on the task value of the experience and expectancy of success [7]. According to SEVT, if someone expects to succeed in an academic context and values the learning experience, they will be motivated to achieve. Fig. 1 reflects the adaptation of Eccles' SEVT constructs for this study.

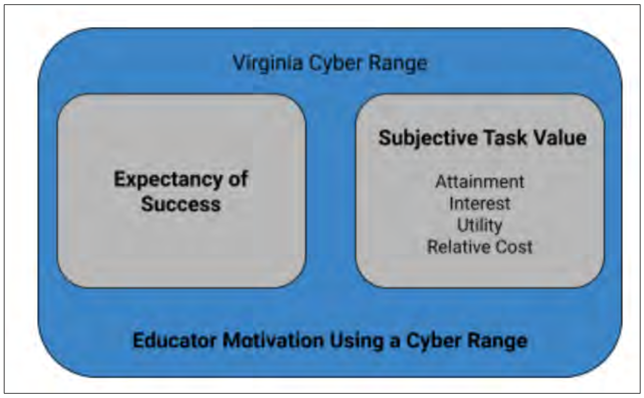

Fig. 1. Cybersecurity Educator Motivation for Using a Cyber Range

There are multiple motivational theoretical frameworks with similar constructs relative to ability beliefs. For example, Bandura's self-efficacy construct [17] relates to ability beliefs. However, in addition to expectancy of success, which relates to how confident one feels in their ability to succeed at the task, the SEVT constructs also include subjective task values such as attainment, interest, utility, and relative costs [7, 8, 18, 19]. Attainment value refers to the importance placed on performing the task well. Interest value, or intrinsic motivation, refers to task enjoyment. Utility value refers to the usefulness of the task in one's future, also referred to as extrinsic motivation. Relative costs refer to how much effort the task will involve, taking away time from other more enjoyable activities [20, 21]. This understanding was relevant to describing educators' expectancy to succeed using the cyber range and how they valued using cyber ranges for cybersecurity education. Table 1 reflects the constructs of this study.

TABLE 1 SEVT CONSTRUCTS FOR THIS STUDY

SEVT Construct	Description Construct for this Study
Expectancy of Success	Confidence educators have in their ability to use the Virginia Cyber Range (VaCR) for cybersecurity education
Attainment Value	Importance of using the VaCR for cybersecurity education
Interest Value	Interest-enjoyment in using the VaCR for cybersecurity education
Utility Value	Usefulness of using the VaCR for cybersecurity education
Relative Cost	The costs incurred by using the VaCR for cybersecurity education

Eccles' SEVT was initially developed to explain the motivation of elementary children in mathematics [18]. However, it is now widely used throughout education fields [20, 22-25]. Engineering education researchers have used SEVT to study engineering faculty and student motivation [26-30].

SEVT is the theoretical framework in several studies of teachers and their motivation, to include studies of teacher career choice motivations [31], types of beginning teachers based on their motivational profiles [32], understanding teacher technology integration from the expectancy-value perspective [33], motivational factors underlying middle and high school teachers' use of problem-based learning [34], motivational differences of teachers throughout their preparation and careers [35], and motivational factors that influence faculty to adopt effective engineering teaching practices [29].

The work by Cheng et al. [33] found that educators who expected to succeed using technology in classes tended to use technology more often in their classrooms. They also found that educators who felt that integrating technology was interesting and enjoyable tended to use technology more often. A study of factors that influence faculty motivation in their practices of effective engineering teaching found several factors that influenced faculty to include knowledge and skills of effective teaching practices, student experience, time, networking and community [29]. While another study found educators who taught using problem-based learning (PBL) had more formal professional development than educators who did not use PBL [34]. They also found educators who used PBL had higher levels of value for PBL, perceived competence in using this pedagogy, and perceived support from peers. Similar to previous studies using Eccles' SEVT framework, this work explored educator motivation using a new, innovative approach, a cyber range, to teaching and learning.

IV. Research Methods

This study used a concurrent mixed-methods approach [36] to draw upon the strengths of both qualitative and quantitative methodologies to explore, compare, and determine evident patterns in the data to understand how the cyber range motivated educators from the educator perspective.

The VaCR was the unit of analysis. The data sources were the educator responses to a questionnaire and information from the VaCR, such as resource usage and traffic data. The questionnaire consisted of both closed and open-ended items. The closed-ended items anchored the open-ended items. The items were analyzed concurrently to understand why educators value cyber ranges and why they expect to succeed using them through the constructs of SEVT. The study was conducted in accordance with the human subject's research requirements and necessary ethical considerations to protect the educator participants' identities.

A. Data Collection

The primary data source were responses to an anchored open-ended (AOE) questionnaire sent to the VaCR registered educators to obtain a sample of cybersecurity educators. Appendix A contains the questionnaire. Additional sources were the VaCR website and traffic data provided by the administrators of the VaCR to gather resource usage data. Combining the data sources improved validity through triangulation [37, 38].

1) Sampling Plan: The population for this study were educators who used cyber ranges for cybersecurity education. The sampling used a purposive non-probability sampling approach of studying the educators who used the VaCR [39]. The reason for purposely selecting the VaCR was due to its focus on cybersecurity education.

The VaCR is only accessible to educators via required registration which provided a means to send the AOE questionnaire to all the registered members to obtain a diverse sampling or heterogeneity sampling [39]. This approach supported the goal to capture all views regarding how educators were motivated using the cyber range.

The questionnaire was emailed to the 264 registered VaCR educator users. Responses were from 85 educators who provided varying amounts of questionnaire responses, of which 70 of the 85 reported using the VaCR during the 2020 - 2021 academic year. From the 70 survey respondents, 35 - 37 participants responded to the SEVT items analyzed to understand how cybersecurity educators are motivated when using a cyber range. The variance in responses was due to some participants not responding to all the items. Due to the exploratory nature of this study, the responses to the individual items were analyzed individually and contributed towards a rich understanding.

2) AOE Questionnaire and Traffic Data: AOE questions use the responses to closed-ended questions as foundations (or anchors) for accompanying responses to open-ended questions. One study found that AOE questions provided the ability to sort many responses more quickly than open-ended questions and more accurately than closed-ended questions [40]. The closed-ended questions in this study were analyzed quantitatively using a Likert scale of one for strongly disagree to seven for strongly agree. The anchored open-ended questions provided detailed responses that connected to the closed-ended questions. For example, a closed-ended question regarding interest agreement was followed with an anchored open-ended item for the participant to explain why they agreed or disagreed. Similar open-ended items also addressed closed-ended items regarding the usefulness, relative costs, and the other SEVT constructs.

The instrument was created in Qualtrics and included items for two separate studies. Qualtrics' built-in instrument analysis feedback indicated that the instrument was overly lengthy and may reduce response rates. Therefore, this study implemented methods for increasing response rates. While expected response rates to academic surveys are 25% to 30% for emailed questionnaires [41], a multi-mode approach was found to increase response rates to 72% [42]. This study used follow-up emails and a gift card drawing incentive to achieve higher response rates. Study participants were entered in a random drawing of ten $50 Amazon gift cards in June 2021 to encourage higher and timely participation. Despite these efforts, this study's 32% response rate reflected a minimal improvement over the typical 25% to 30% [41].

The VaCR administrators provided the traffic data reports. These reports captured used resources, the time of usage, duration, and frequency of usage. Additionally, the VaCR website provided descriptions of the available resources. The traffic data reports, and website information supported the data provided by the educators through their questionnaire responses.

B. Analysis

For each SEVT construct, the associated closed-ended questionnaire items were quantitatively analyzed separately. The results for each closed-ended question were sorted based on the Likert scale values. Analysis of the anchored open-ended responses produced codes anchored by levels of agreement and disagreement. A code table organized the codes for each SEVT construct by the closed-ended responses and level of agreement or disagreement response. The responses to the anchored open-ended questions were coded using theoretical a priori and descriptive coding [43, 44]. The first coding cycle used the five constructs of Eccles' SEVT motivation theoretical framework of expectancy of success, attainment value, interest value, utility value, and relative costs [8]. The second cycle of coding identified concepts and emerging patterns.

The subsequent analysis stage was concept identification. Pattern and focused coding for the second cycle of coding categorized the coded data into the primary concepts per SEVT construct by clustering the codes with a common concept theme. The resulting concepts that emerged through the analysis provided an understanding of how the educators were motivated using the cyber range.

The descriptive findings from the coding analysis of the anchored open-ended responses of how educators were motivated corroborated the results from the analysis of the closed-ended items. Reliability analysis used Cronbach Alpha for internal consistency of the instrument's items per construct [36]. Appendix B contains the results from the reliability analysis. An open-source statistical spreadsheet, Jamovi, analyzed the closed-ended responses to compare how educators were motivated per construct [45]. Clustered bar charts displayed the findings from the closed-ended data. Results for each SEVT construct are depicted on a separate chart. Each chart contains clustered bars for each Likert-value per questionnaire item associated with the specific SEVT construct.

Variations in motivation were also analyzed using t-tests and assumption checks for homogeneous variances between groups to determine statistical differences in the SEVT constructs per two-group comparisons [38]. Motivation comparisons included novice versus experienced teachers, K-12 versus higher education educators, and those who identified as males versus those who identified as females. For purposes of this study, these first-time cybersecurity educators are referred to as novices. Since there were insufficient participants who identified as non-binary, the analysis focused on the binary male/female groupings.

C. Role of Researcher

The primary researcher (first author) identifies as a director of a university's Institute for Cybersecurity which includes a cyber range. Additionally, having facilitated K-12 cybersecurity summer camps and outreach efforts, they have considerable interest in furthering K-12 cybersecurity education. Overseeing a cyber range at their university and being responsible for its practical use, the researcher seeks to understand how educators are motivated by using cyber ranges to ensure the findings are valid and credible. The second author has little cybersecurity experience and provided guidance on use of the SEVT framework and on methods.

D. Quatlity of Research

1) Quality of Instrument for Data Collection: When designing the instrument, guidance was sought to ensure the questions addressed appropriate content and structure (e.g., did not lead the participants towards a specific position). The closed-ended items were taken from an existing instrument and modified to reflect the needs of the study of motivation using cyber ranges for cybersecurity education. However, recognizing these modifications caused the original validity and reliability to no longer hold [36], it was necessary to reestablish through pilot testing and reliability analysis of the response data. Two cybersecurity educators that use the VaCR agreed to complete the questionnaire and provide feedback. Their review included the clarity of the questions, how they interpreted the questions, and the ease of completing the questionnaire, which improved the instrument and content validity.

2) Quality of Data Analysis: A fellow researcher cross-checked the codes for qualitative analysis by randomly selecting some of the questionnaire data to code using the same frameworks [36]. Their cross-check was implemented before coding all the data to compare and analyze codes and concepts. The researcher created a codebook in Microsoft Excel with a separate sheet for each SEVT construct. Each sheet included the associated concepts, their definitions, and the associated codes for each concept. Using the provided codebook, the fellow researcher coded the open-ended responses provided in a table format. The initial codes and concepts were blacked out during the second researcher's coding review and then made visible again afterward to compare their results to the initial coding. The fellow researcher's effort supported the identified concepts for the AOE responses.

V. Results

Addressing the first research question regarding how cybersecurity educators are motivated using a cyber range, the results reveal four key findings. Fig. 2 reflects the findings from the closed-ended responses with the Costs scored reversely.

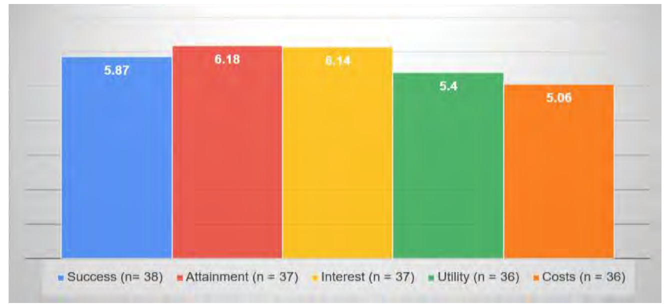

Fig. 2. Educator Motivation by SEVT Construct

1. Most educators who used the VaCR taught at the high school level and did not have a formal cybersecurity background or experience. Those who were confident they had the skills and could learn the skills needed to use the VaCR for cybersecurity education (expectancy of success) shared a willingness to self-study and utilize PD opportunities to learn more about cybersecurity and the VaCR.

2. Educators wanted to be the best cybersecurity educators they could be and believed integrating the VaCR improved their cybersecurity classes (attainment value). They believed that being adept at using the VaCR in their classes improved their cybersecurity pedagogy, contributing to them being better cybersecurity educators.

3. Educators valued the VaCR content and how it contributed positively towards student interest (interest value) and overall student engagement due to its relevant cybersecurity content and ready-to-use resources (utility value).

4. Educators recognized that if they did not spend the time and effort to educate themselves, they would be emotionally stressed in class because they were unprepared and would appear incompetent in front of their students (relative costs). They needed time to learn how to use the VaCR and prepare their courses to integrate it effectively (relative cost).

The quantitative analysis found educators were primarily motivated by the importance of using the VaCR for cybersecurity education (attainment value), their interest in using the VaCR for cybersecurity education (interest value), and their confidence in their ability to use the VaCR for cybersecurity education (expectancy of success). Educators were slightly less motivated by the usefulness of using the VaCR for cybersecurity education (utility value) and the costs of using the VaCR for cybersecurity education (relative costs).

A. Motivation per SEVT Construct

Through qualitative analysis of the AOE responses, motivation concepts emerged for each SEVT construct. The VaCR content itself contributed to three constructs: expectancy of success, attainment value, and interest value. Pedagogical improvement emerged for two task value constructs, attainment, and interest, while student benefits emerged for interest value (student engagement) and utility value (student professional development). Time and effort were the primary costs that emerged and prevented the emotional cost of stress. Educators needed time due to a lack of prior experience or background in cybersecurity. A comprehensive view of how cybersecurity educators are motivated using the VaCR with supporting excerpts from those who agree and disagree with each SEVT construct of academic motivation is provided in Appendix C.

1) Success: Based on the closed-ended questions, educators are very confident they have and can learn the skills necessary to use the cyber range, provided they have time to do so. When compared to other educators, their neutral responses of neither agree nor disagree were due to not having a metric for comparing themselves with others, or they believe they are better than some but not as strong as others. Fig. 3 depicts the responses for items within the Expectancy of Success.

From the AOE, the main concepts that emerged through qualitative analysis of all AOE questions regarding educators' expectancy of success using the VaCR for cybersecurity education were prior experience, preparation time, and the VaCR content itself. Educators who agreed at some level shared prior experience, prior education, cybersecurity background, or years of cybersecurity teaching were primary reasons for agreeing. A reason for confidence was the willingness to take time to prepare and utilize PD opportunities such as GenCyber and self-study.

Additionally, some felt the VaCR was intuitive and easy to use. They shared that using the VaCR improved their knowledge and skills. Educators who disagreed at some level shared that a lack of prior experience or background in cybersecurity was the primary reason for disagreeing. Preparation time was another factor as most felt they had the skills to learn but lacked time to dedicate to learning. Additionally, many shared that they were starting at "ground zero" and found the VaCR challenging to navigate and lacking instructional material to support educators who had no prior cybersecurity knowledge.

2) Attainment: Based on the closed-ended questions, none of the educators disagreed with wanting to become a better cybersecurity educator. Most shared that using the VaCR to teach cybersecurity education assisted their teaching efforts. Those who neither agree nor disagree that they are becoming better cybersecurity educators by using the cyber range shared a need for further professional development. Some also felt inadequate even though they recognized the importance of cybersecurity education for today's world. Fig. 4 depicts the responses for items within the Attainment construct for SEVT.

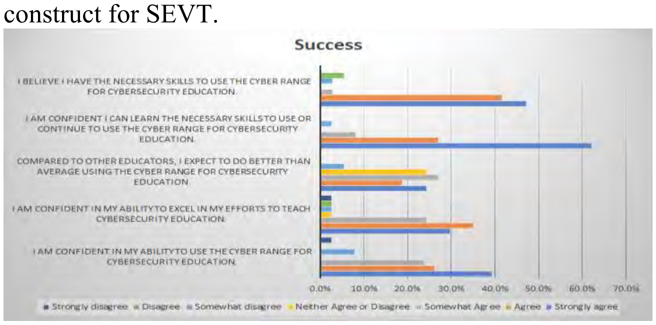

Fig. 3. Clustered Bar Chart of Success-Related Closed-Ended Questions

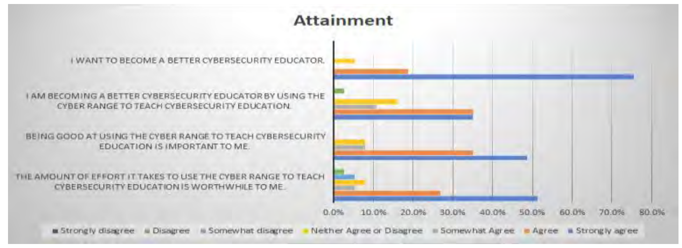

Fig. 4. Clustered Bar Chart of Attainment-Related Closed-Ended Questions

The main concepts that emerged through qualitative analysis of all AOE questions regarding the personal importance of using the VaCR for cybersecurity education were a professional mindset, cybersecurity pedagogy, and the VaCR content itself. Many educators who agreed at some level shared aspects that reflected a professional mindset that valued being prepared and competent in their profession. They felt educators needed to be lifelong learners to provide their students with relevant and current cybersecurity knowledge. Additionally, they wanted to enhance their cybersecurity pedagogy by using methods that supported their students' learning. They found that learning to navigate the VaCR environment was worthwhile to ensure labs and activities ran smoothly.

They also shared that the VaCR content itself contributed to using the cyber range for cybersecurity education. The VaCR provided hands-on learning, meaningful experiences, relevant knowledge applications, and the ability to "jump right in" versus wasting time troubleshooting virtual machine (VM) set up issues that students experience when building their own VMs. The primary reason that educators disagreed that the effort was worthwhile was because of the time necessary to become familiar with the VaCR. Some shared that it took a considerable amount of time to figure out, as it was not intuitive. The VaCR needed to be more user-friendly and better organized. A course sequence would assist their efforts to use the cyber range. Most recognized the importance of cybersecurity education; however, they disliked feeling inadequate in the classroom.

3) Interest: Although Interest was the second most motivating construct from the closed-ended responses, the reasons that emerged from the AOE for the interest were primarily related to their students' interest in using the cyber range. Educators who reported neutral responses in the closed-ended items, neither agreeing nor disagreeing, found it was challenging to use the VaCR with their students or they could not use it in a manner that met the needs of their course. Educators who agreed at some level on the closed-ended items were primarily due to their students' interest and enjoyment using the cyber range. Fig. 5 depicts the responses for items within the Interest construct for SEVT.

The main concepts that emerged across all AOE questions regarding cybersecurity educators' interest in using the VaCR for cybersecurity education were positive student engagement, support for cybersecurity pedagogy, and the VaCR content itself. Educators who agreed at some level shared that using the VaCR hands-on labs and activities were engaging and supported students' excitement about the discipline and profession. The VaCR provided students access to learning that the school and technology restrictions had prevented otherwise. Educators shared that their students' engagement was contagious.

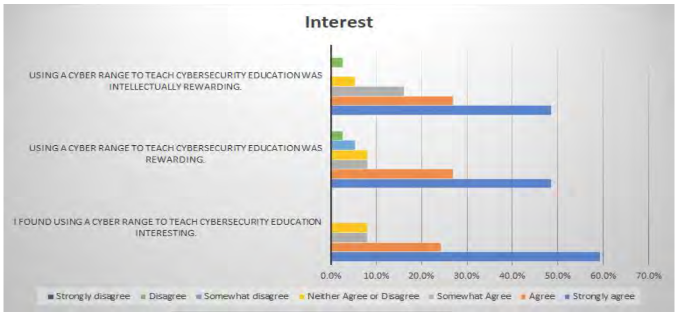

Fig. 5. Clustered Bar Chart of Interest-Related Closed-Ended Questions

They also shared that their instruction would suffer without the ability to integrate the hands-on practice. The tools and resources made their job easier, they valued lessons that were created by experienced cybersecurity educators and included real-life applications. Those who agreed also found using the VaCR interesting due to the VaCR content. Educators found the CTF intellectually interesting and used it significantly in their course. They shared that VaCR provided a realistic and safe environment. The primary reason educators disagreed was a lack of prior experience or understanding. The COVID level of requirements was also time-consuming and left them too tired to learn something new.

4) Utility: Many responses to the closed-ended questions were neutral, neither agreeing nor disagreeing that using the cyber range would lead to other working opportunities because the educators were not looking for other opportunities. Those who agreed shared a belief that it would lead to working opportunities for their students: as one of the educators shared, "I do not see how the cyber range would lead directly to working opportunities for me, but for my students, experience [with] this would be important." Fig. 6 depicts the responses for items within the Utility construct for SEVT.

The main concepts that emerged across all AOE questions regarding the usefulness of using the VaCR for cybersecurity education were the student's professional readiness development, the overall real-world relevance, the need for everyone to have a basic level of cybersecurity literacy, and the ability to apply the content in their other courses. Educators who agreed at some level shared that students who used the VaCR developed stronger cybersecurity skills that contributed to the students' professional readiness compared to students who did not have the hands-on practical experience using the VaCR.

They also believed everyone needs to be cyber literate to be aware of real-world, relevant cyber concerns. The VaCR further develops good online practices and knowledge applicable to everyday life since technology is everywhere. Finally, the cybersecurity resources from the VaCR transferred to other courses they teach to keep the content current and relevant. Cybersecurity concepts even integrated into other subject areas, such as a business class for personal finance and a discussion of identity theft.

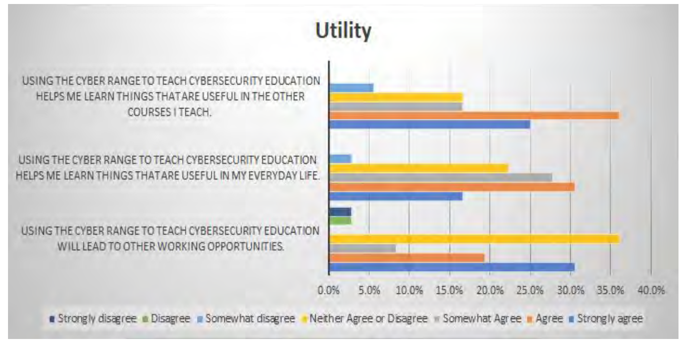

Fig. 6. Clustered Bar Chart of Utility-Related Closed-Ended Questions

5) Costs: Based on the closed-ended questions, educators agreed that time, effort, and emotional stress were relative costs of using the VaCR. However, they also stated these were necessary costs in their profession because continued learning was needed to stay relevant and be an effective instructor, especially in cybersecurity education. Neutral educators, neither agreeing nor disagreeing, stated a few different reasons. The VaCR did not align with their course goals. They lacked the necessary preparation time to integrate it due to COVID demands. They found no costs to using the VaCR as it was enjoyable, rewarding, and accessible. Fig. 7 depicts the responses for items within the Costs construct for SEVT.

The main concepts that emerged across all AOE questions regarding the costs incurred by using the VaCR for cybersecurity education were time, effort, and stress. Educators who agreed with these costs stated that the VaCR required a higher level of knowledge than many of them currently have; thus, it would take a great deal of time and effort to use it. Time costs were acceptable to avoid stress costs. It was a choice of costs to either spend time preparing and losing personal time with family or be highly stressed due to lack of class preparation.

They also stated that taking the time and effort to use the VaCR and learn how to use it prevented emotional stress from not answering student questions or assisting them in class. They shared a need for better instructions that are easier to understand, as well as a "where to begin" section for instructors and course sequencing. Educators who disagreed shared that learning new things always takes effort and preparation. It is a recognized part of the profession of teaching. Some shared that the VaCR had easy-to-follow instructions to get started and integrate the labs and lessons into their classes. They felt it was user-friendly but recognized a learning curve existed for beginners.

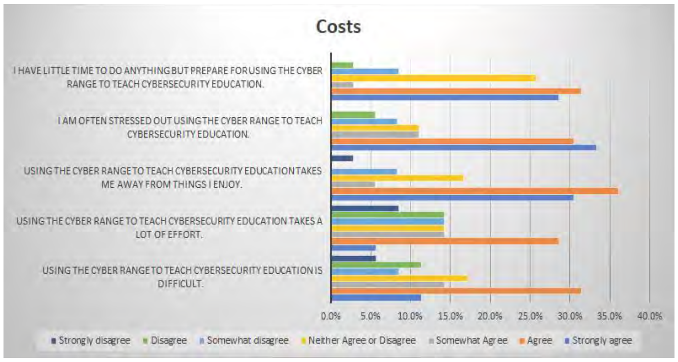

Fig. 7. Clustered Bar Chart of Cost-Related Closed-Ended Questions

B. Variations in Motivation

In addressing the second research question regarding variations in motivation based upon educator demographics, the results did not reflect any significant variation when comparing motivation by instructional level or by cybersecurity teaching experience. The only significant variation was interest motivation based upon gender with a high effect size (Cohen's d = 0.815) as seen in Fig. 8, those who identified as males had more interest than those who identified as females. Assumption checks, such as homogeneity tests, were also conducted and did not identify any violation of the assumption of equal variances.

There was no significant difference between K-12 and higher education educators or between novice cybersecurity educators who taught cybersecurity for the first time in 2020 - 2021 and those who had at least two years of experience teaching cybersecurity. Appendix D contains the resulting information from these analysis tests.

VI. Discussion

The findings from this study describe how educators are motivated using cyber ranges for cybersecurity education. Cyber range developers and cybersecurity education stakeholders should draw from the results of this study to further cybersecurity educational efforts. The overall summary of the results is the following:

1. K-12 Cybersecurity educators require relevant and accessible resources and PD.
2. Educators are positively motivated to integrate cyber ranges in cyber security education.
3. Educators perceive their students as positively motivated when integrating cyber ranges.
4. Integration of cyber ranges in cybersecurity education is challenging for educators; requiring considerable time and effort.

A. Cybersecurity and Cyber Range Professional Development

Educators who lack prior experience, education, or background require preparation time and PD. The VaCR is not intuitive for teachers who do not have a formal background in cybersecurity or experience using a cyber range. Those who utilized PD opportunities such as formal PD workshops and self-study resources shared confidence in their ability to learn how to use the VaCR for cybersecurity education. They need further understanding of cyber range usefulness in education and user-friendly resources geared towards beginners to include mapping VaCR resources to cybersecurity education learning objectives. Providing formal cybersecurity and cyber range PD would contribute positively towards cybersecurity educator expectancy of success

This shortfall reflects a similar need that contributed to the limited success of engineering in K-12 education [47]. According to a study conducted by the National Academy of Engineering and the National Research Council of the National Academies, not only were learning standards missing for engineering education, but additionally, guidance for effective PD was also sparsely available [48]. The study did not find any pre-service content that assisted pre-service educators' readiness to become "qualified engineering educators in the near future" [48: 9].

Independent Samples T-Test

Independent Samples T-Test

		Statistic	df	p		Effect Size
avgS	Welch's t	1.43	19.7	0.168	Cohen's d	0.508
	Mann-Whitney U	117.0		0.164	Rank biserial correlation	0.280
avgA	Welch's t	1.58	16.1	0.133	Cohen's d	0.590
	Mann-Whitney U	108.0		0.171	Rank biserial correlation	0.280
avgI	Welch's t	2.15	15.0	0.048	Cohen's d	0.815
	Mann-Whitney U	86.5		0.032	Rank biserial correlation	0.423
avgU	Welch's t	1.53	15.6	0.146	Cohen's d	0.577
	Mann-Whitney U	111.0		0.272	Rank biserial correlation	0.229
avgC	Welch's t	1.13	17.7	0.275	Cohen's d	0.415
	Mann-Whitney U	114.5		0.329	Rank biserial correlation	0.205

Group Descriptives

	Group	N	Mean	Median	SD	SE
avgS	Male	25	6.05	6.00	0.870	0.174
	Female	13	5.54	6.00	1.12	0.311
avgA	Male	25	6.35	6.50	0.696	0.139
	Female	12	5.83	5.88	1.02	0.296
avgI	Male	25	6.43	7.00	0.785	0.157
	Female	12	5.56	6.00	1.29	0.372
avgU	Male	24	5.61	5.33	0.843	0.172
	Female	12	4.97	5.33	1.32	0.382
avgC	Male	24	5.27	5.80	1.284	0.262
	Female	12	4.65	4.50	1.67	0.481

Fig. 8. Variation in Motivation by Gender of VaCR Educators

Although some PD offerings were available, they were usually offered by independent sources with different perspectives regarding critical engineering concepts, such as engineering design and how engineering connected to the other STEM disciplines. At the time of the study, there were no explicit descriptions of the knowledge and skills educators needed to teach K-12 engineering effectively. Brophy stated that educators' significant barrier to effectively teaching engineering is their lack of pedagogical content knowledge (PCK)[47].

PCK combines general teaching knowledge, also referred to as pedagogical knowledge, and content knowledge of the subject they teach [48]. Since most educators did not have a background in engineering or knowledge on how to assist students in understanding challenging engineering concepts, they lacked the readiness to be effective engineering teachers. The committee on K-12 Engineering Education recommended a national dialogue regarding the efforts and challenges of K-12 engineering educators to understand the PD needs specific to engineering education.

Efforts to successfully implement K-12 cybersecurity education should also include research to understand the needs for teacher readiness specific to cybersecurity education, including Cybersecurity PCK. The findings from Brophy et al. regarding educators not having a background in engineering or knowledge of assisting students in understanding challenging engineering concepts are also applicable to cybersecurity [47]. As seen in the results of this study, many cybersecurity educators reported they do not have a background in cybersecurity or a background in knowledge necessary to assist their students' understanding of challenging cybersecurity concepts. Educators will need effective cybersecurity PD to ensure they are better prepared to teach cybersecurity and use cyber ranges.

B. Cyber Range Integration into Education

Most educators shared a general agreement on the importance of using the VaCR for cybersecurity education. Using the VaCR supported their ability to integrate the hands-on application of their course content to improve student learning and understanding of cybersecurity in a safe and accessible environment. They felt that using the VaCR strengthened their cybersecurity PCK and supported their ability to become better cybersecurity educators. These value and competence beliefs about VaCR integration aligned with prior studies. For example, Cheng et al. found that when teachers believe a technology contributed positively towards their pedagogical practices (value beliefs) and they expected to succeed at integrating the technology effectively in their class (competence beliefs), they then tend to increase the usage of the technology [33].

Thus, cybersecurity education stakeholders should continue to support cyber range integration in cybersecurity education programs to strengthen cybersecurity education programs and support educators' ability to become better cybersecurity educators. These stakeholders should also support further research efforts to understand how cyber ranges contribute to educators' cybersecurity pedagogical content knowledge. This understanding contributes to developing cyber range resources to support cybersecurity educators teaching efforts.

C. Student Interest and Engagement

Educators value the VaCR as a resource that improves their cybersecurity-related courses by providing students with accessible, hands-on, relevant labs and CTFs in a safe environment that their students find interesting and engaging. Hidi and Renniger cited multiple previous studies that found a person's interest strongly influenced their learning; specifically, their interest influenced their attention, goals, and levels of learning [49]. Findings from their study suggest that initial student interest can lead to longer-term sustained and internalized interest. This sustained interest leads to the well-developed individual interest, which values the content more than alternative activities [49].

Cybersecurity stakeholders should continue efforts to integrate cyber ranges in cybersecurity education programs as educators reported doing so promotes student interest and engagement. Recognizing the importance of cybersecurity education to address the cybersecurity workforce need, the findings from this study support the integration of cyber ranges in cybersecurity education to engage students and prepare them for the cybersecurity specialist profession. Cybersecurity stakeholders should also support further studies of student interest to understand how cyber ranges contribute towards students' sustained interest in cybersecurity.

D. Educator Time and Effort

Many educators shared they had a professional mindset in which they recognize that the teaching profession requires being a life learner and that learning something new requires time and effort. The VaCR is a recently available tool for most educators. Taking time and effort to learn how to use the VaCR prevents emotional stress associated with not being prepared in class, as educators want to be competent in front of their students. Many K-12 educators reported they were teaching multiple disciplines, with each subject requiring time and effort for lesson preparation. Prior studies found that preparation time and time for learning about effective teaching practices influenced educators' adoption of effective teaching practices [29].They also contributed to why educators were less likely to persist at teaching [32]. Academic administrators can provide support and encouragement to their educators with additional time and resources for PD and time to prepare supporting content to integrate cyber ranges. Further study is needed to understand how the support addresses educators' motivational costs of time, effort, and stress.

E. Limitations

This research has limitations common to all studies; however, these limitations do not invalidate the findings. The main limitation of this study was the use of one cyber range to understand cyber ranges, which vary in approaches, purposes, and users. [46:377] states that "the idea behind qualitative research is to gain understanding about some phenomenon." The methods for studying the VaCR may transfer to another location based upon what readers learn from the study that they can then apply to new situations to meet their needs [38]. Miles, Huberman, and Saldana [43] provides several criteria for increasing the transfer of the findings of a study to other contexts. These criteria refer to providing sufficient, thick, and full descriptions of the persons, settings, processes, findings, and outcomes.

Another limitation was that the participants were purposely selected instead of representative, and therefore, the transferability of findings from one location to another may be limited. Additionally, the educators who participated in this study did so voluntarily. Thus, self-selection bias may have existed. The sample may have also skewed towards educators who had strong opinions towards using cyber ranges; therefore, this study may not represent all views and does not claim to do so. However, through rich and detailed descriptions, this study provides readers the opportunity to determine the "fittingness" of the findings to their own experience and situations [38: 350], increasing the transferability and the replication of the results in future studies [43].

A third limitation to this study was the inability to conduct a confirmatory factor analysis of the instrument. Due to the small population of registered Virginia Cyber Range educators, the researcher did not have a large enough sample to conduct this analysis. Nonetheless, this study does not make claims of generalizability. Instead, it contributes to understanding how some educators who use the VaCR are motivated using the VaCR for cybersecurity education.

VII. Conclusion and Future Studies

Cybersecurity education is still a relatively recent discipline. Collaborative efforts between cybersecurity education stakeholders in government, industry, and academia would contribute to establishing standards and assessments and teacher readiness with effective PD. These efforts must be informed with relevant research to further widespread access and effectiveness of K-12 cybersecurity education and minimize the challenges experienced by K-12 engineering education efforts.

Understanding why educators value cyber ranges and why they expect to succeed using a cyber range informs the community at large why the integration of the cyber range is valued, how it contributes to success in teaching and learning, and what aspects were not valuable. Although cyber range developers are knowledgeable about what their range has to offer, the perspective of the educator who uses the cyber range to teach is invaluable and necessary for making informed decisions regarding the addition or implementation of a cyber range and the continued development of its resources. Educators valued using cyber ranges and believed using them for cybersecurity education and professional readiness was important. However, educators who lack prior experience, education, or background require preparation time and professional learning opportunities. Efforts to successfully implement cybersecurity education should include research to understand the needs for teacher readiness specific to cybersecurity education.

Future studies may include interest variations among educators using a cyber range who identify as male versus female and the relationship between cybersecurity educators' expectancy of success using a cyber range versus the relative costs of time and effort before and after participating in a cybersecurity PD program.

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APPENDIX A – ANCHORED OPEN-ENDED QUESTIONNAIRE

State your level of agreement on a scale of 1 (strongly disagree), 2 (disagree), 3 (somewhat disagree), 4 (Neither agree or disagree), 5 (somewhat agree), 6 (agree), and 7 (strongly agree), to the following statements, where applicable.

A. Success

1. I am confident in my ability to use the cyber range for cybersecurity education. Please explain why:

2. I am confident in my ability to excel in my efforts to teach cybersecurity education. Please explain why you are/are not confident in your skills and abilities to teach cybersecurity education:
3. Compared to other educators, I expect to do better than average in teaching cybersecurity education. Please explain why:
4. I am confident I can learn the necessary skills to use the cyber range for cybersecurity education. I believe I have the necessary skills to teach cybersecurity education.
5. Please explain why you are or are not confident you can learn the skills to use or continue to use the cyber range and teach cybersecurity education:

B. *Attainment Value*

6. The amount of effort it takes to use the cyber range to teach cybersecurity education is worthwhile to me.
7. Being good at using a cyber range to teach cybersecurity education is important to me.
8. Please explain why being good at using the cyber range to teach cybersecurity education is or is not important and/or worth the effort.
9. I am becoming a better cybersecurity educator by using the cyber range to teach cybersecurity education.
10. I want to become a better cybersecurity educator.
11. Please explain why you want or don't want to become a better cybersecurity educator and how the use of the cyber range to teach cybersecurity contributes or not contribute to this ability.

C. *Interest Value*

12. I found using a cyber range to teach cybersecurity education interesting.
13. Please explain why:
14. Using a cyber range to teach cybersecurity education was rewarding
15. Using a cyber range to teach cybersecurity education was intellectually rewarding.
16. Please explain why using the cyber range was or was not interesting, rewarding, and/or intellectually rewarding.

D. *Utility Value*

17. Please describe how you found the cyber range useful and/or not useful for teaching cybersecurity education.
18. Using a cyber range to teach cybersecurity education will lead to other working opportunities.
19. Please explain why you agree or disagree.
20. Using a cyber range to teach cybersecurity education helped me learn things that are useful in my everyday life.
21. Using a cyber range to teach cybersecurity education helped me learn things that are useful in the other courses I teach.
22. Please explain why using the cyber range to teach cybersecurity education helps or doesn't help you learn things that are useful in your everyday life and/or in other courses you teach.

E. *Relative Costs*

23. Using a cyber range to teach cybersecurity education is difficult.
24. Using a cyber range to teach cybersecurity education takes a lot of effort.
25. Please explain why you agreed or disagreed with the two statements above regarding difficulty and effort using the cyber range for cybersecurity education.
26. Using a cyber range to teach cybersecurity education takes me away from things I enjoy.
27. I am often stressed out by using the cyber range to teach cybersecurity education.
28. I have little time to do anything but prepare for using the cyber range to teach cybersecurity education.
29. Please explain any costs associated with using the cyber range. These costs could be related to social costs, emotional costs, economical costs or other costs related to efforts not associated with using the cyber range.

Appendix B – Reliability Analysis

Motivation Construct	**Scale Reliability Statistics Cronbach's α**
Success	0.843
Attainment	0.761
Interest	0.876
Utility	0.729
Costs	0.922

Appendix C – Educator Motivation Concepts By SEVT Constructs with Supporting Excerpts

Motivation Construct & Concepts	**Excerpts from educators who agree at some level**	**Excerpts from educators who disagree at some level**
Success Prior experience Preparation Time Virginia Cyber Range Content	"I have a lot of experience in networking and network engineering, so I have strong background experience." "The Gen Cyber Camp along with spending time mastering the labs and coming up with my own labs and assessments has given me the confidence to use the VaCR in a relevant, engaging way with my cyber classes." "The Cyber range is putting out a lot of material and they are taking great strides in simplifying their interface. It is a good resource, and I am personally committed to putting it to good use."	"I have no training in cybersecurity and no professionally developed material is provided. Your material is likely the best but no training was given to me on how to use it and it is not intuitive to figure out. When the class is one of four preps, dedicating the necessary amount of time to figure all of this out and have a personal life is basically impossible."
Attainment Professional Mindset Pedagogy Virginia Cyber Range Content	"I only think the cyber range makes me better in that it frees up some of my time to spend on other educational improvements. I do think it is important to strive to be better as an educator in each passing semester." "Practical skills help me teach cybersecurity better and the more hands-on work I can give my kids, the better they will be. It's good for the [students], good for the Commonwealth, and good for the Country!"	"This environment is much more valuable to the students because it has actual hands-on exercises. It takes a lot of work to figure out. A course sequence would be so helpful to teachers like myself."

Interest Student Engagement Pedagogy Virginia Cyber Range Content	"Yesterday I had my cybersecurity fundamentals students run the Denial-of-Service lab in class. Their excitement of successfully completing the lab was contagious." "Using the cyber range opened up new experiences for me as well as my students, it gave my students as well as myself an opportunity to "work" in cyber security." "I don't believe I could have taught the classes as effectively without this tool. I am very appreciative to have this as a tool. I wish I had more time to learn more about the Cyber-Range." "The cyber range makes you think about what you are doing it is not just a follow the instructions and this will happen site. I enjoy the challenge of working through the exercises."	"The Cyber Range does not provide a mechanism to install OSs [Operating Systems] on VM's. That is part of what I needed to teach in my classes, therefore the Cyber Range is too lacking for my use." "It certainly has the potential to be, but my level of understanding has to improve before I feel more strongly about that aspect." "The subject matter is intellectually stimulating, but this entire school year has been overwhelming and I am exhausted. I did not have the time or energy to commit to learning to use it fully."
Utility Student Development & Professional Readiness Cybersecurity Literacy & Real-World Relevance Crossover Application	"Everything I read, all the industry professionals I speak to give me the same message, hands-on training is invaluable. It is more likely to get my kids hired than nearly anything else I can provide." "EVERYONE needs to know more about this stuff. The more we know and understand, the better we can keep from being the weak link in our own organizations' cyber defenses." "It increases awareness of exposure in the digital world. The topics naturally flow into other courses just through informal discussions, workplace readiness skills, etc."	"I was extremely excited to get access to the cyber range and to use it for my courses, however, I was disappointed that the limitations of the VMs were set so low as to be unusable for my purposes." "It is useful to be more aware of cyberthreats and how to avoid them. I see few direct connections to physics."
Relative Costs Time Effort Stress	"I know I need to fully run through the exercises I find before assigning them to the students so I know if they will work, if students need better directions, etc. So I lose time with my family if I do that or am highly stressed using it if I don't." "Although the range has very responsive support, sometimes the instructions provided are not as clear as they could be. Assume that the person asking has little to no experience and provide instructions on that basis. That comment applies	"The learning curve is a little steep but once you get the hang of it, it makes sense. Navigating the Kali desktop can get a little confusing if you're looking for an app but it comes clearer after a bit." "I disagree because the range has everything you need, you just have to put forth the effort to use it." "Because everything that has any real intrinsic value requires work so just step up and do it. And learning to teach using Cyber Range is no more difficult than learning how to drive a car. Learning to use things you've never used before always has effort included with the package."

APPENDIX D – VARIATION IN VACR EDUCATOR MOTIVATION

Independent Samples T-Test

		Statistic	df	p		Effect Size
avgS	Welch's t	1.5988	35.9	0.119	Cohen's d	0.5103
	Mann-Whitney U	130		0.176	Rank biserial correlation	0.2614
avgA	Welch's t	−0.5569	32.6	0.581	Cohen's d	−0.1846
	Mann-Whitney U	142		0.426	Rank biserial correlation	0.1548
avgI	Welch's t	−0.4061	31.2	0.687	Cohen's d	−0.1354
	Mann-Whitney U	158		0.748	Rank biserial correlation	0.0625
avgU	Welch's t	0.0995	33.8	0.921	Cohen's d	0.0328
	Mann-Whitney U	149		0.724	Rank biserial correlation	0.0719
avgC	Welch's t	0.1010	33.8	0.920	Cohen's d	0.0333
	Mann-Whitney U	153		0.835	Rank biserial correlation	0.0437

Group Descriptives

	Group	N	Mean	Median	SD	SE
avgS	college	16	6.15	6.20	0.750	0.188
	high	22	5.67	5.80	1.089	0.232
avgA	college	16	6.09	6.00	0.841	0.210
	high	21	6.25	6.50	0.851	0.186
avgI	college	16	6.06	6.17	1.096	0.274
	high	21	6.21	6.67	1.025	0.224
avgU	college	16	5.42	5.33	0.881	0.220
	high	20	5.38	5.33	1.197	0.268
avgC	college	16	5.09	5.20	1.195	0.299
	high	20	5.04	5.80	1.623	0.363

Fig. D.1. T-Test Analysis Results comparing Cybersecurity High School vs College Level Educators

Independent Samples T-Test

		Statistic	df	p		Effect Size
avgS	Welch's t	−1.693	5.89	0.142	Cohen's d	−0.844
	Mann-Whitney U	48.0		0.056	Rank biserial correlation	0.5000
avgA	Welch's t	−0.623	5.81	0.557	Cohen's d	−0.315
	Mann-Whitney U	83.5		0.706	Rank biserial correlation	0.1022
avgI	Welch's t	−0.512	6.00	0.627	Cohen's d	−0.253
	Mann-Whitney U	87.0		0.812	Rank biserial correlation	0.0645
avgU	Welch's t	−1.717	5.37	0.143	Cohen's d	−0.828
	Mann-Whitney U	42.5		0.112	Rank biserial correlation	0.4516
avgC	Welch's t	−0.247	5.60	0.814	Cohen's d	−0.116
	Mann-Whitney U	68.5		0.696	Rank biserial correlation	0.1161

Group Descriptives

	Group	N	Mean	Median	SD	SE
avgS	Novice	6	5.10	5.40	1.28	0.521
	Experienced	32	6.02	6.00	0.863	0.152
avgA	Novice	6	5.92	6.25	1.20	0.490
	Experienced	31	6.23	6.50	0.766	0.138
avgI	Novice	6	5.89	6.50	1.39	0.569
	Experienced	31	6.19	6.33	0.984	0.177
avgU	Novice	5	4.67	5.00	1.03	0.460
	Experienced	31	5.52	5.33	1.025	0.184
avgC	Novice	5	4.92	5.00	1.36	0.609
	Experienced	31	5.08	5.80	1.460	0.262

Fig. D.2 T-Test Analysis Results comparing Cybersecurity Novice vs Experienced Educators

Independent Samples T-Test

		Statistic	df	p		Effect Size
avgS	Welch's t	1.43	19.7	0.168	Cohen's d	0.508
	Mann-Whitney U	117.0		0.164	Rank biserial correlation	0.280
avgA	Welch's t	1.58	16.1	0.133	Cohen's d	0.590
	Mann-Whitney U	108.0		0.171	Rank biserial correlation	0.280
avgI	Welch's t	2.15	15.0	0.048	Cohen's d	0.815
	Mann-Whitney U	86.5		0.032	Rank biserial correlation	0.423
avgU	Welch's t	1.53	15.6	0.146	Cohen's d	0.577
	Mann-Whitney U	111.0		0.272	Rank biserial correlation	0.229
avgC	Welch's t	1.13	17.7	0.275	Cohen's d	0.415
	Mann-Whitney U	114.5		0.329	Rank biserial correlation	0.205

Group Descriptives

	Group	N	Mean	Median	SD	SE
avgS	Male	25	6.05	6.00	0.870	0.174
	Female	13	5.54	6.00	1.12	0.311
avgA	Male	25	6.35	6.50	0.696	0.139
	Female	12	5.83	5.88	1.02	0.296
avgI	Male	25	6.43	7.00	0.785	0.157
	Female	12	5.56	6.00	1.29	0.372
avgU	Male	24	5.61	5.33	0.843	0.172
	Female	12	4.97	5.33	1.32	0.382
avgC	Male	24	5.27	5.80	1.284	0.262
	Female	12	4.65	4.50	1.67	0.481

Fig. D.3. T-Test Analysis Results Comparing Cybersecurity Educator Gender