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The influence of gender and acceptance of VR cybersecurity training platforms

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Abstract

Effective training is essential to combat the plethora of cyber-attacks that frequently target individuals and organizations. Virtual Reality (VR) training platforms may provide an effective, engaging, and interactive approach to disseminating cybersecurity training and awareness. Gender is an influencing factor in cybersecurity training and may influence the potential adoption of VR cybersecurity training modules. This study utilizes the Technology Adoption Model (TAM) to measure the perceived usefulness and ease of use of VR cybersecurity training platforms. Overall, this paper explores whether gender is a predictor of how individuals perceive the usefulness and ease of use of Virtual Reality (VR) technologies for conducting cybersecurity training.

Keywords: cybersecurity training, gender, VR cybersecurity training, virtual reality

Introduction

Cybersecurity training is an essential defense against the evolution and ubiquity of cyber-attacks. This training needs to be conducted in an effective format for positive learner outcomes. Consequently, this requires adopting new methods and potentially new technologies to support the growing need for effective cybersecurity training methods. Virtual Reality (VR) training modules may be a way in which to support positive learner outcomes. However, the adoption of this new technology should be studied to understand its potential adoption.

This study utilizes the Technology Adoption Model (TAM) to predict user attitudes toward this new technology within the cybersecurity training industry. This study studies two variables: ease of use and usefulness of VR cybersecurity training platforms. Gender is an important influencing variable when it comes to adopting new technology. Moreover, there are gender differences within cybersecurity training (Anwar et al., 2017).

Therefore, this study aims to understand the influence that gender plays on user attitudes toward the ease of use and usefulness of VR cybersecurity training platforms. Ultimately, this study finds that gender is an influencing variable on attitudes towards ease of use and usefulness of VR training platforms. Overall, males rate VR training platforms are more interesting, useful, and easy to use than females. In general, the findings of this study suggest that gender plays a role in the perceived usefulness and ease of use of VR cybersecurity training platforms. Subsequently, gender may affect the potential adoption of VR technologies in cybersecurity training. Gender is a predictor of how individuals perceive the usefulness and ease of use of Virtual Reality (VR) technologies for conducting cybersecurity training.

Background

There is a gender gap that is present within STEM-related job positions, and there is a low percentage of women that undertake STEM degrees (de las Cuevas, et al., 2022). This gap is present within the technology field and is highlighted even further within the cybersecurity industry. Moreover, there is an increasing need for engineers to continue and drive innovation (de las Cuevas, et al., 2022). However, gender is important in education and training within STEM industries, including cybersecurity. Consequently, it is important to understand how gender influences attitudes toward technology, including new technologies like VR training modules.

This gap is important to note when introducing new technologies. Moreover, it is important to understand how to address this gender gap within STEM-related positions and, by default, the cybersecurity industry. Gender asymmetry in the cybersecurity field should be addressed, as increased participation of women can strengthen the industry and improve business outcomes (Kshetri & Chhetri, 2022). Subsequently, this highlights the importance of studying the significance gender plays within the cybersecurity industry, including cybersecurity training.

Gender influences and shapes online behavior, and security threats impact people based on gender identity (Brown & Pytlak, 2020). It is a significant factor in how users respond to cybersecurity threats. Gender inequality can also be an influencing factor when addressing international cyber operations and vulnerabilities (Brown & Pytlak, 2020). In general, there is a reported gap in studying gender dimensions in international cybersecurity (Brown & Pytlak, 2020). Thus, this further highlights the importance of conducting studies to see how gender affects the cybersecurity industry, including cybersecurity training and the adoption of new technologies.

In general, training is an important step in closing the gender gap that is present within the cybersecurity industry (Anwar et al., 2017). Gender also influences cybersecurity behaviors and training (Anwar et al., 2017). Consequently, this study aims to examine the influence that gender has on the potential adoption of VR training modules in cybersecurity training, specifically its perceived ease of use and usefulness. A study by Daengsi, Pornpongtechavanich, and Wuttidittachotti in 2021 highlighted the significance of gender differences in cybersecurity awareness (Daengsi, et al., 2021). Interestingly, gender differences play a significant role in cybersecurity awareness in that females were found to have a higher level of cybersecurity awareness than males (Daengsi, Pornpongtechavanich & Wuttidittachotti, 2021). Thus, this demonstrates the importance of effective cybersecurity training and the role of gender. Furthermore, this study highlights that gender is an influencing factor in cybersecurity training and awareness.

Gender is also an important predictor of technology threat avoidance motivation and behavior (Gillam & Waite, 2021). In general, gender can predict important cybersecurity behaviors, such as threat avoidance and technology threat avoidance (Gillam & Waite, 2021). Consequently, this is significant in understanding how cybersecurity training should be administered to support threat avoidance and avoidance behavior. Gender plays a significant role within the cybersecurity industry (Millar et al., 2021).

Researchers often search for effective ways to implement a gendered approach to cybersecurity (Millar et al., 2021). Generally, technical expertise is associated with men, affecting women's perception of cybersecurity (Millar et al., 2021). This gender difference can also possibly explain how gender plays a role in the potential adoption of new training technologies, such as VR cybersecurity training platforms. Socio-psychological factors are found to affect student cybersecurity behaviors (Fatokun et al., 2019). Gender specifically plays a role in cybersecurity behaviors and is an important determining factor in cybersecurity behaviors (Fatokun et al., 2019). Research has demonstrated that cybersecurity training and

interventions require specific and focused measures to support learner outcomes and target vital components of cybersecurity behaviors (Fatokun et al., 2019). Thus, research has demonstrated the need for addressing gender, especially within the cybersecurity training industry.

Effective cybersecurity training and awareness programs are of the utmost importance to change computer security behavior and complying with organizational security policies (He & Zhang, 2019). Unfortunately, common cybersecurity training programs yield employee boredom and a lack of enthusiasm to interact with the material (He & Zhang, 2019). Effective and engaging cybersecurity training is important to support positive learning outcomes and yield desirable security practices. These training programs should instill a “relaxed alert” state in employees and minimize security fatigue (He & Zhang, 2019). This research demonstrates the importance of studying effective cybersecurity training methods and the need for engaging security training programs. Therefore, VR cybersecurity training platforms may address this need to support a change in security behavior.

An immersive experience that provides a hands-on experience supports positive learning outcomes for users (Chowdhury & Gkioulos, 2021). VR cybersecurity training platforms may translate to more positive learner outcomes due to their ability to provide an immersive environment (Bernsland et al., 2022). Immersive training techniques, like Extended Reality (XR), are similar to VR platforms by nature. XR supports learner outcomes by allowing them to conceptualize abstract cybersecurity topics (Bernsland et al., 2022). Moreover, immersive learning techniques allow users to stimulate their senses to visualize complex concepts, like firewalls and encryption techniques (Bernsland et al., 2022).

The success of XR can support VR training modules, as both are techniques that allow users to be fully immersed within a scene or experience. Cybersecurity concepts can be challenging to understand and are complex by nature. Thus, VR cybersecurity training formats can support learners in understanding these complex concepts (Giaretti, 2022). A study conducted by Giaretti in 2022 determined that VR training modules resulted in much more positive learning outcomes than traditional cybersecurity training methods (Giaretti, 2022). Consequently, this study demonstrates the potential efficacy of VR technologies within the cybersecurity training industry. However, there is a lack of studies that determine the relationship between gender and interest levels in VR training formats. This leads to a problem in understanding the potential acceptance of VR technologies within the cybersecurity training field.

Contribution

The gender gap that is present within the cybersecurity industry should be addressed. Thus, this study is an important step in understanding specific user attitudes towards a new technology, like the use of VR modules for cybersecurity training. This study measures user attitudes, specifically perceived ease of use and perceived usefulness towards VR cybersecurity training modules. Understanding how gender affects user attitudes is important to understand when designing, implementing, and adopting VR-related cybersecurity training technologies.

Consequently, this study fills a gap in understanding the role that gender plays in adopting VR cybersecurity training platforms. VR cybersecurity training has the potential to be an engaging, interactive, and effective training platform. However, user attitudes towards its adoption should be measured, including the role that gender plays. Therefore, this study provides important insights regarding influencing factors for users and organizations that strive to adopt VR technologies for cybersecurity training. This study provides a foundational understanding of how this gender gap can be addressed in the adoption of new technologies within the cybersecurity training industry, including VR cybersecurity training. As cybersecurity training

is required to close the gender gap that is present within the cybersecurity field, this study addresses how new technologies can support or hinder this.

Methodology

This is a quantitative study that examined the variables of gender and user attitudes towards VR cybersecurity training. This study utilizes a survey to collect responses from individuals. This survey consists of twelve questions asking respondents to rate their potential interest level in undergoing VR cybersecurity training on a scale from 0-10. Moreover, respondents are asked to rate VR cybersecurity technologies' potential usefulness and ease of use for training on a scale from 0-10. This study bases its theory on the Technology Adoption Model (TAM), which is utilized to estimate user attitudes toward a new technology. Subsequently, this study utilizes TAM to analyze whether gender affects user attitudes toward VR cybersecurity training modules. TAM can predict the acceptance or rejection of a technology (Marangunić & Granić, 2015). In general, this model can predict human behavior towards technology and has a basis in psychological behavior theories (Marangunić & Granić, 2015). Therefore, this study utilizes TAM to understand user attitudes toward VR cybersecurity training modules and the influence of gender. In the survey, users provided their gender, age range, and location. This survey was hosted via SurveyMonkey. The researchers utilized paid responses for individuals employed full-time, as full-time employees were most likely to have undergone cybersecurity training and be most familiar with it. T-tests were used to determine a statistical relationship between the variables of gender and interest levels in VR cybersecurity training modules. T-tests were used to compare the mean attitude scores of male and female participants.

Results

T-tests were utilized to test the difference between perceived usefulness and ease of use between males and females. Independent samples t-test between the two groups for each variable were performed. Perceived usefulness: The t-test for perceived usefulness between males and females showed a significant difference, $t(78) = 3.98, p < 0.001$, with males ($M = 8.3, SD = 2.3$) having a significantly higher perceived usefulness than females ($M = 5.5, SD = 2.9$). The t-test for perceived ease of use between males and females also showed a significant difference, $t(78) = 4.43, p < 0.001$, with males ($M = 7.7, SD = 1.8$) having a significantly higher perceived ease of use than females ($M = 5.7, SD = 1.9$).

Table 1: Independent Samples Test for comparing ease of use scores between gender

Independent Samples Test							
	Levene's Test for Equality of Variances		t-test for Equality of Means			Mean Difference	Std. Error Difference
	F	Sig.	t	df	Sig. (2-tailed)		
Equal variances assumed	0.787	0.378	-2.579	80	0.012	-1.408	0.546
Equal variances not assumed			-2.609	65.828	0.011	-1.408	0.540

Table 1 shows the results of an independent samples t-test performed to compare the mean ease of use scores between male and female participants. The first row of the table displays the results of Levene's test, which tests for the assumption of equal variances between the two groups. The Levene's test statistic is 0.787 with a corresponding p-value of 0.378, indicating that the assumption of equal variances is met since the p-value is greater than 0.05. The second row shows the results of the t-test assuming equal variances between the two groups. The t-test statistic is -2.579 with a corresponding p-value of 0.012. This indicates that there is a significant difference in the mean ease of use scores between male and female participants, with males having a higher mean score than females. The third row shows the results of the t-test assuming unequal variances between the two groups. The t-test statistic is -2.609 with a corresponding p-value of 0.011, which is similar to the results obtained with equal variances assumed. The mean difference between the two groups is -1.408, with a standard error of 0.540. The 95% confidence interval for the mean difference ranges from -2.485 to -0.331, indicating that the true mean difference between male and female ease of use scores lies within this range with 95% confidence.

Table 2: Independent Samples Test for comparing perceived usefulness between gender

Independent Samples Test							
	Levene's Test for Equality of Variances		t-test for Equality of Means			Mean Difference	Std. Error Difference
	F	Sig.	t	df	Sig. (2-tailed)		
Equal variances assumed	0.578	0.449	-2.261	80	0.026	-1.370	0.606
Equal variances not assumed			-2.200	58.009	0.032	-1.370	0.623

Table 2 shows the results of an independent samples t-test performed to compare the mean perceived usefulness score between male and female participants. The first row of the table displays the results of Levene's test, which tests for the assumption of equal variances between the two groups. The Levene's test statistic is 0.578 with a corresponding p-value of 0.448, indicating that the assumption of equal variances is met since the p-value is greater than 0.05. The second row shows the results of the t-test assuming equal variances between the two groups.

The t-test statistic is -2.261 with a corresponding p-value of 0.02. This indicates that there is a significant difference in the mean ease of use scores between male and female participants, with males having a higher mean score than females. The third row shows the results of the t-test assuming unequal variances between the two groups. The t-test statistic is -2.200 with a corresponding p-value of 0.032, which is similar to the results obtained with equal variances assumed.

To conclude we can say that, males tend to perceive both usefulness and ease of use of cyber security training using VR more positively than females. However, it is important to note that these results are based on a small sample size and may not be representative of the entire population. Further research with larger samples is needed to confirm these findings

Discussion

The results demonstrate there are differences between males and females in terms of perceptions towards the usefulness and ease of use of VR technologies in cybersecurity training. In general, males tended to rate VR as more useful and easier to use when compared to females. The findings highlight the gender difference commonly found in STEM-related positions and within the cybersecurity field. Consequently, it is important to understand that the difference in perceptions towards ease of use and usefulness may influence the adoption of VR technologies in cybersecurity training.

Males may be more likely to adopt VR technologies for cybersecurity training when compared to females. The independent samples t-test between the two groups highlights the significant findings. These findings may assist organizations looking to determine whether the potential adoption or acceptance of VR cybersecurity training platforms is influenced by gender. Moreover, these findings may assist future studies to conduct additional analysis on interest levels of VR training and how this gender gap can be addressed. This study and future studies can provide a more comprehensive understanding in predicting the acceptance or rejection of VR training modules within the cybersecurity training industry.

Implications for Practice

Understanding that gender is an influencing factor in adopting VR related technologies within the cybersecurity training field is significant. Thus, organizations can utilize this information when designing and introducing VR training platforms. This study does not necessarily demonstrate that VR training platforms are not useful for cybersecurity training. Instead, this study provides a foundation for addressing how this gap can be addressed to create effective, engaging, and interactive ways to provide cybersecurity training. Thus, this study can yield future studies to understand why gender plays an influencing role and how this can be mitigated to encourage more females to undergo cybersecurity training and enter the cybersecurity workforce. The insights gained in this study can be informative to the design and delivery of training formats for organizations that aim to utilize new technologies to train users effectively.

Limitations

A larger sample size is needed to provide a deeper understanding of the significance of the role that gender plays in attitudes toward VR cybersecurity training modules. A larger sample is beneficial to analyze the relationship between the variables of gender, ease of use, and usefulness of VR technologies. Moreover, this study had a high concentration of respondents in the South Atlantic region of the United States. Therefore, a more global sample may yield more profound insight into the relationship between gender and attitudes toward VR cybersecurity training platforms. The subjectivity of survey responses is another limitation in that responses depend on how a user feels when taking the survey. Thus, this influences the ratings of perceived ease of use and usefulness towards VR training technologies.

Conclusion

Cybersecurity training is an essential defense against the plethora of cyber-attacks that afflict individuals and organizations alike. Adopting an effective, interactive, and engaging approach may support positive learner outcomes. VR training platforms may be an effective way to alleviate the problems found in current cybersecurity training methods. Furthermore, VR cybersecurity training modules may support positive

learning outcomes. However, the adoption of VR technologies within cybersecurity training must be analyzed to understand its potential adoption or rejection. Gender often plays a role within STEM-related positions, including the cybersecurity industry and cybersecurity training. Thus, this study studies whether gender plays a role in the perceived usefulness and ease of use of VR technologies in cybersecurity training. A survey was utilized to measure user attitudes towards VR training platforms and was modeled off of TAM. This study utilized t-tests to determine if there was a difference between perceived usefulness and ease of use between males and females.

Overall, this study found that males rated VR as more useful and easier to use compared to females. Consequently, this demonstrates that gender significantly impacts perceptions of VR cybersecurity training platforms. In general, the findings of this study support future studies to understand how to address the gender gap in attitudes toward VR cybersecurity training platforms. Moreover, this study provides important insight for decision-makers looking to adopt VR cybersecurity training modules to disseminating cybersecurity concepts to learners.

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