More skilled internet users behave (a little) more securely

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CONF '22, Jan 1 - Dec 31 2022, Authorberg.
 ACM 978-1-xxxx-yyyy-z/zz/zz…$zz.00.
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Abstract
Usable security researchers have continuously explored social and demographic factors, and even beliefs, that affect user security behavior. However, no formal study of the relationship between internet skill and security behavior has been conducted. In this poster, we present a survey of 102 Amazon Mechanical Turk workers. We find small, but significant, connections between internet skill and user behavior with regard to password generation, updating, and proactive awareness.

Author Keywords
Web-use skills; SEBIS; security behavior, internet skills

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction
A significant body of work in the usable security community has focused on trying to understand user behavior. Prior work has examined social factors, demographics, and even mental models as factors [1,2,3,4]. However, there has been no prior work, to our knowledge, formally evaluating the impact of internet skill on security behavior.

As a first step toward analyzing the relationship between internet skill and security behavior, we

conducted a 10-minute closed-item survey of 102 Amazon Mechanical Turk workers. Our survey contained the Security Behavior Intentions Scale (SEBIS) to assess users security intentions on four dimensions: passwords, updating, proactive awareness, and device securement [7]; the Web-use Skills Index to assess internet skill level [5]; and four demographic questions.

We hypothesized that users with few skills would perform few security behaviors, users with mid-level skills would perform many security behaviors, and users with high skill levels would perform few behaviors, due to more knowledge conveying a sense of invincibility. Our data, however disproves this hypothesis. We find a small but significant relationship between respondents' scores on the Web-Use Skills Index and their scores on the three of the four SEBIS subscales: password generation, updating and proactive awareness. Furthermore, we find evidence that older adults are slightly more likely to update their devices and software and women are significantly more likely to secure their devices from attackers they know (e.g. to use passcodes).

Background and Related Work

In this section we present prior work on measuring users' internet skill levels and security behavior intentions.

Measures of Internet Skill

Hargittai and Hsieh developed the web-use skills index to assess users internet skill level [5]. This index tests whether people understand different internet-related terms, such as Wiki and Malware. There are multiple versions of this measure, all with high validity, from six to 27 items in length. Another measure of internet skills, developed by van Deursen et al. is the Internet Skills Scale (ISS) [6]. ISS measures users' internet skills with 35 questions about operational, information navigation, social, creative, and mobile skills. As both measures have comparably strong validity, we chose to use the Web-use Skills Index as it is shorter and thus more conducive to an online survey.

Measures of Security

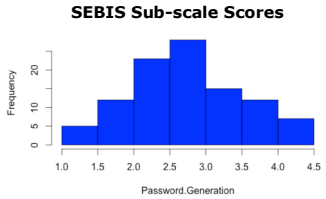
Camp et al. designed a measure of security expertise that consists of open-response questions, Boolean questions, and multiple-choice queries [10]. In contrast to explicitly measuring expertise, Egelman and Peer developed the Security Behavior Intention Scale (SEBIS) to assess users' intention to complete different security behaviors [7]. SEBIS is a 16-item scale that consists of four subscales: device securement, password generation, proactive awareness, and updating software. SEBIS has been validated to predict actual user security behavior [11]. We chose to use SEBIS because we are interested in behavioral intentions, rather than expertise, and the SEBIS measure has been more extensively validated.

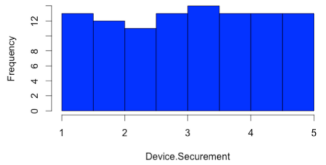
Thus far, SEBIS has been used to measure end users' security intentions and to correlate these intentions with personality traits. We expand on this prior work by examining the relationship between internet skills, as measured by the web-use skills index, and security behavior, as measured by SEBIS.

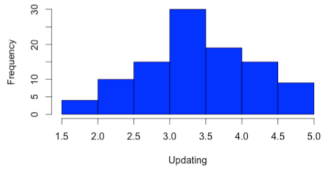
Methodology

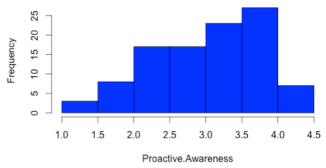
We surveyed 102 respondents to understand if there is a correlation between users' internet skill level and their security behaviors. To do so, we administered SEBIS to assess respondent's security behaviors and

Respondents









the web-use skills index to measure participants' internet skills. The University of Maryland Institutional Review Board approved this survey.

We recruited respondents using Amazon's Mechanical Turk (MTurk). Participants were compensated with $1 for completing a 10-minute closed-item survey containing the 16-item SEBIS measure, the 10-item version of the Web-use skills index intended for the general population, and four demographic questions.

To minimize ordering effects, participants randomly received either SEBIS or Web-use skills items first. Demographic questions, which included age, gender, race/ethnicity, and educational attainment, were always asked at the end of the survey to minimize sensitivity and bias.

Results

In this section we present an overview of our sample and our findings regarding the relationship between internet skills and security behavior intentions.

Respondents

Forty-seven percent of our participants were female, slightly less than the US population (51%) [9]. Our sample was younger than the population, with 86% of our respondents under the age of 50, compared with 67% of the US population [8]. The educational attainment of our sample was also slightly higher than that of the US population [8,9]. This is typical of MTurk populations [13], and given that SEBIS was validated on MTurk and the web-use skills index was validated with an undergraduate student population, we are comfortable that our sample was reasonable for the measures we used. Our sample was racially representative except with regard to White (77% vs. 62%) and Hispanic (6% vs. 17%) respondents [9]. This sample bias may be the result of question wording– our race/ethnicity question was combined into a select all that apply option, which may have led to some Hispanic respondents to select only the White answer choice.

Finally, the mean Web-Use Skills score of our sample was 4.19 and the mean scores for SEBIS were: Password Generation (μ=2.89), Updating (μ=3.52), Device Securement (μ=3.11), and Proactive Awareness (μ=3.13). The distributions of these scores are shown in the left sidebar.

As Internet Skills Increase, Some Security Behaviors Increase

To evaluate the relationship between internet skill and security behavior, we used regression models to fit our data. We modeled our data with both linear and polynomial regression models in order to determine whether the relationship between internet skill and security behavior was linear, or polynomial shaped as we had hypothesized. Each of the four SEBIS sub-scale scores was an outcome to one linear and one polynomial model, and all of the models had Web-Use Skills index score as the sole input feature. The fitting curves of linear and second-order polynomial regression models are presented in Figs. 1-2. These figures show that the two fitted curves are close. The same three subscales, password generation, updating and awareness were significant ($p<0.05$) or near significant ($p<0.06$) in both the linear and polynomial regressions. More data may be needed to determine which regression model best explains the security behavior-internet skill relationship, as our internet skill data is

Internet Skill vs. SEBIS

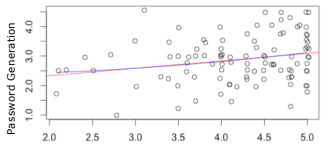


Figure 1:Linear (red) and polynomial (blue) regression on Password Generation SEBIS sub-scale vs. Web-Use Index Score (internet Skill level).

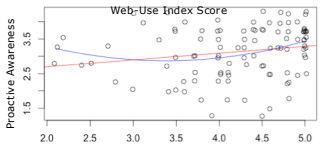


Figure 2:Linear (red) and polynomial (blue) regression on Proactive Awareness SEBIS sub-scale vs. Web-Use Index Score (internet Skill level).

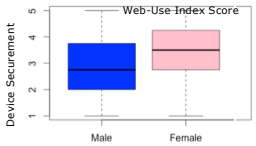


Figure 3: Scores of Male and Female respondents on the Device Securement sub-scale of SEBIS. Regression model showed significant connection between gender and score.

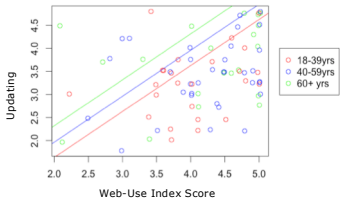


Figure 4: Linear regression models of best fit by age group.

right skewed — with dense data for high internet skill indices and sparse data for low ones.

Impact of Demographics on Behavior

We also evaluated the impact of demographics on security behavior by adding age, gender, and education as features in our models. Given that we could not draw a clear conclusion regarding the shape of our data, we chose to conduct this analysis with linear regression models. To minimize over-fitting, we eliminate one factor from the model at a time, until we minimize the Akaike information criterion (AIC). The final models for Password Generation and Proactive Awareness included only the Web-Use Skills Index as a feature. The final model for Updating included both age and the Web-Use Skills Index. Although each of the age variables was not significant in the model, together they had a positive impact on AIC, thus indicating that older people may be very slightly more likely to perform software updates. Finally, device securement, which was not correlated with Web-Use Index Score, resulted in a final model containing only gender as a feature. The regression results for all final models are listed in Table 1.

Discussion

Our findings suggest a significant, but small, positive relationship between internet skill level and security behavior on three of the four SEBIS sub-scales: Password Generation, Updating, and Proactive Awareness. Our results disprove our hypothesis that users with greater internet skills would practice fewer security behaviors due to feeling invincible.

Additionally, we find that demographic factors impact respondent behavior on two of the security sub-scales: Device Securement and Updating. Gender, specifically being female, was significantly connected with choosing to secure one's device. This seems logical, as women are generally more concerned with physical security than are men, and device securement can protect against physical-world attackers [12]. We also found that older adults are slightly more likely to update their devices, perhaps because they are more consistent in following updating routines than are younger adults.

Finally, due to the highly right-skewed distribution of Web-Use Skills Scores in our sample we were unable to verify whether the relationship between internet skill and security behavior is linear or polynomial. This distribution most likely due to the fact that MTurk respondents tend to be technically skilled, so future work may explore conducting a similar study with a more representative population [13]. Such a study may present some challenges, however, as the SEBIS measure has only been validated with the MTurk population.

Outcome	Factor	Coef	SE	*p*-value
Password Generation	IS	0.25	0.11	0.019
Proactive Awareness	IS	0.12	0.10	0.055
Device Securement	Gender(F)	0.47	0.21	0.027
Updating	IS	0.21	0.10	0.038
	Age: 18-39	0.37	0.73	0.616
	Age: 40-59	0.04	0.73	0.961
	Age: 60+	0.32	0.79	0.686

Table 1. Final linear regression results for each of the SEBIS subscales. IS stands for the Web-Use Skills measure.

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