The Theory of Successful Behavior: A Theoretical Explanation of Successful Novice Cyber Security Practitioners

Research-in-Progress

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I. INTRODUCTION

There are some good theories that explain why people attempt certain activities: for example the Theory of Reasoned Action (TRA) [1], the Technology Acceptance Model (TAM) [2], the Theory of Planned Behavior (TPB) [3], the Unified Theory of Acceptance and Use of Technology (UTAUT) [4]. However, none of those theories explain if the person attempts that activity whether they will engage in successful behavior during their activity. There are some theories that explain successful behavior in limited ways: for example Cognitive Fit Theory (CFT) [5], Task-Technology Fit (TTF) [6], and Delone and McLean IS Success Model [7]. However, these theories only explain a few antecedents of successful behavior. Self-Efficacy Theory (SET) [8]—and its application to computers; Computer Self-Efficacy (CSE) [9]—does predict specific successful computer behaviors by mediating most variables with a self-efficacy construct. However, there are many other variables, such as conceptual expertise of the phenomenon, predicted by other theories, that SET and CSE do not account for. There are also management theories about managing performance, but they do not try to predict successful behavior. There are goal theories and motivational theories. These types of theories do not account for skills. In short, there does not seem to be a comprehensive theory regarding successful behavior. A reason for the lack of scientific theory seems to be that competency is typically viewed as a professional or regulatory concern [10]. However, being able to explain why someone will engage in successful behavior in the future can help researchers better understand the antecedents of successful behavior and will help practitioners know which individuals to hire and what needs to be trained or developed in those individuals.

This paper expounds upon previous theories to construct a theory explaining engagement in successful behavior. We propose to test this theory in the context of novice cyber security professionals engaging in security practices. Thus, this paper adds to current literature by 1) creating an encompassing theory about successful behavior, 2) testing antecedents of successful behavior with cyber security novices, and 3) adding three contextual variables to typical behavioral models: low experience, high pressure, and team dynamics.

II. THEORETICAL DEVELOPMENT

This paper starts by introducing the propositional model of the Theory of Successful Behavior (see Figure 1). This paper will expound upon the logic for each of the paths and constructs in the model starting with the definition of successful behavior and the direct effects to successful behavior.

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Fig. 1. Propositional model of the Theory of Successful Behavior

A. Successful Behavior

TRA [1], TAM [2], TPB [3], and UTAUT [4] all focus on a particular behavior or more specifically the intention to perform a particular behavior [11], [12]. However, what this paper tries to predict is not a specific behavior that can be encapsulated and measured as intentional or not (e.g., the use of a particular software) but the engagement in a set of behaviors, often unconsciously, that will cause a person to be successful at a certain task. Therefore, successful behavior is more akin to performance.

Performance is often defined as the speed and accuracy of the individual’s actions during the task [5]. Performance is a function of the task strategies or “methods [and] processes required to perform the task” [5, p. 220] used during the task. It is this definition of task strategies that is most closely aligned with the construct this paper is interested in predicting.
Unlike Vessey’s [5] definition, many tasks (e.g., chess) do not have “required” processes but they often have multiple processes that will lead to the desired outcome. Hence we do not seek to predict a single behavior, nor do we strive to predict the optimal (i.e., least resource intensive) behavior. Rather we seek to predict the engagement in any behavior that is likely to lead to a success outcome. Therefore, this paper defines successful behavior as the engagement in methods or processes that lead to successful performance of a task.

B. Self-Efficacy

Successful performance of a task is largely a function of previous performance [8]. Meaning that people are better able to perform a task the more they have successfully performed the task in the past. This concept has been colloquially stated as “perfect practice makes perfect.” Underlying this claim is the concept that people’s experiences are coded and retained as symbols or models in memory [13] that are retrieved and used to guide further action [8]. People’s mental models are refined through self-corrective adjustments as they perform the task [8]. Through reoccurring activity people lean towards beneficial actions and avoid punishing actions [8]. In a sense, people are recognizing positive and negative patterns from sequences of events as they perform an action many times [8].

People’s belief about their future performance is called efficacy expectations. Efficacy expectations are “convictions that [oneself] can successfully execute the behavior required to produce [an] outcome” [8, p. 193]. Efficiency expectations vary on magnitude, the difficulty level people can handle, generality, the number of contexts in which people can perform, and strength, how strongly people believe their expectations [8].

There are four major sources of efficacy expectations: enactive attainments, vicarious experiences, persuasion, and physiological states [8], [14]. Enactive attainments are past performances of the task that are either successful or unsuccessful. Successes will increase while failures will decrease efficacy expectations. Vicarious experiences are the observation of others succeed or fail through their efforts. Observing other people succeed will increase efficacy expectations due to social comparison and a mentality that if someone else can succeed, I must be able to achieve at least some improvement [8]. Education works off of the principle of observing others. Vicarious experiences is how support groups operate. While weaker than the previous two forms, verbal persuasion can also increase efficacy expectations. Verbal persuasion is the suggestion by others that a person can successfully accomplish a task [8]. Physiological states, specifically emotional arousal, also affect efficacy expectations as people use expected stress and anxiety as a measure of the effort that will have to be exerted to successfully perform the task. The more people expect stress, or are already stressed, the more effort they expect they will have to put into the task and the more likely they are to avoid the task altogether, and therefore they expect that they will less likely succeed [8].

Efficacy expectations influence people’s choices as they will choose activities and settings in which they think they will perform better as well as the amount of effort they will exert during the activity [8], [15]. A great example of this choice is the reluctance of many people to switch operating systems due to their familiarity with one operating system and their fear of the other. People with high efficacy expectations will also set higher achievement goals and be firmer in their belief that they can accomplish those goals [15].


Magnitude in computer self-efficacy refers to people’s perception of the difficulty level they can obtain [9]. People with higher magnitude of computer self-efficacy believe they can accomplish more difficult tasks than people with low computer self-efficacy [9]. People with lower computer self-efficacy believe that they can only execute simple tasks [9].

Strength in computer self-efficacy refers to people’s confidence that they can perform the computer tasks given to them [9]. People with strong computer self-efficacy believe that they are more likely to succeed at a computer task than individuals with low strength [9]. The main difference between magnitude and strength is magnitude refers to belief that one can do complex computing and strength refers to one have greater confidence in the execution of computing tasks [9].

Generalizability in computer self-efficacy refers to people’s ability to apply a particular activity to other settings and activities [9]. Thus, a person with high computer self-efficacy generalizability can use their knowledge of one computer program or system to different computer programs and systems efficiently, whereas people with low computer self-efficacy generalizability perceive their capacity as limited to one computer program or system [9].

As self-efficacy determines efficacy expectations that determine successful behavior, computer self-efficacy determines successful behavior in computer tasks [16]. The relationship between expectations and successful behavior can occur at the specific activity level and at the general activity level and the two levels increase the successful behavior of the other level [16]. Thus we posit:

P1. Self-Efficacy increases successful behavior.

C. Conceptual Expertise

Conceptual expertise is “understanding [of a phenomenon] resulting from the accumulation of a large body of knowledge” [17, p. 167]. Conceptual expertise develops from the construction of a mental representation of a task that aids in decision-making [18]–[20]. People use these mental representations as guides for a solution path [21], [22]. The more someone experiences or learns about a phenomenon, the more comprehensive and generalizable their mental representations become [17]. The more people understand a given phenomenon, the more likely they are to have mental representations that will guide the person to successful behavior. For example, chess masters have accumulated enough conceptual expertise to recognize more ways to win that novices have. Therefore, we propose:

P2. Conceptual expertise increases successful behavior.
When people have increased conceptual expertise of a phenomenon, they understand whether they have the cognitive, social, or behavioral skills and subskills to perform a task [14]. When people know that they have the skills to perform a task they are more likely to believe they are going to be successful. Therefore, efficacy expectations mediate conceptual expertise [14]. Therefore we propose:

**P3. Conceptual expertise increases self-efficacy.**

**D. Ambition**

Reinforcement of beneficial actions also leads to increased motivation to perform the task that in turn increases performance [8]. When people believe they will perform better, often because they have performed better in the past, they are more likely to put effort into performing and thus will realize enhanced performance [8]. When people are able to see the fruits of their labor they have increased enjoyment and pride from accomplishing their goals. These elated feelings encourage reoccurring performance that continues the cycle of self-corrective learning. Therefore, people’s belief in their own effectiveness will affect whether they will choose or avoid certain activities during their performance and how long they are willing to persist to overcome obstacles [8]. People that overcome obstacles will obtain self-corrective mental models whereas those that stop prematurely will retain the same debilitating skills and expectations [8].

**P4. Self-efficacy increases ambition**

**P5. Ambition increases performance**

**III. METHODOLOGY**

**A. Study Context**

This article studies successful behavior in the national collegiate cyber defense competition (http://www.nationalccdc.org/). This competition is held annually in the United States of America since 2004. During the competition, teams of mostly undergraduate students (blue teams) attempt to defend themselves from competition hackers (red team). Winners are chosen based on how many services each blue team still has running by the end of the attacks. The competition happens in three rounds: qualifiers, regionals, and nationally. Qualifiers and regionals happen in ten regions (e.g., Mid-West Region). One team from each region goes on to compete nationally.

**B. Participants and Demographics**

Participants will be recruited from all people attempting to qualify for their regional competition. We will communicate to all regional organizers and attempt to obtain the list of competitors or have them forward our emails on to the competitors. In 2015 there were 29 qualifying teams for the Mid-Atlantic Region. Assuming there is at least 10 qualifying teams from each region, and at least 15 teams attempting to qualify, and twelve people per team (twelve is the max roster size, but only eight get to compete), the sample size can be up to 1,800 people. [Demographics will be reported after data collection]

**C. Measurement**

To collect our data, we will send out a survey to all of the participants attempting to qualify for the regional competitions. Our survey will contain measures for all of the constructs in our model except for the dependent variable. The dependent variable will be the level of success that the team achieves (0 = did not qualify, 1 = qualified for regions, 2 = qualified for regionals, 3 = won nationally).

**REFERENCES**


