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The Eureka Effect: Exploring the Benefits of Struggling with Technology

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Research-in-Progress

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Abstract

This research in progress piece adds two interesting theoretical insights to traditional models of adoption. First, it introduces the Eureka effect, which suggests that some types of usage challenges can actually increase satisfaction with the system--even if they decrease the user's perceived ease of use. Second, it expands on expectation-disconfirmation adoption models to carefully problematize when a user's expectations of a system are confirmed or disconfirmed and builds theory in the various liminal states in between preadoption and postadoption. Specifically, this paper builds the foundational base of theory and grounds initial hypotheses to support its two contributions to IS theory.

Keywords: *Adoption, postadoptive use, continued use, TAM, expectation confirmation*

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Introduction

It is said that the great Greek mathematician Archimedes discovered the displacement method to find the volume of an irregularly shaped object while in a public bathhouse. Upon lowering himself into the bathtub and realizing the solution to his problem, he shouted "Eureka!" and ran all the way home—entirely in the nude. While the story of Archimedes may be a myth, the intense feeling of pride and success that are often associated with solving a problem is one that many of us are familiar with. Problem solving in the IS context, however, carries unique baggage; computer systems that offer potential "Eureka!" moments may be perceived by their users as frustrating to use. Thus, even though problem solving to use a system could feasibly result in these feelings of pride, it often results in the opposite outcome.

What, then, determines whether users of computer systems will become upset or inspired after a successful system troubleshooting experience or challenging set-up process? The dominant perspective in IS suggests that users would perceive systems that require some degree of troubleshooting to be more difficult to use than those that do not. Following the logic of the widely-accepted Technology Acceptance Model (TAM) (Davis 1989), software programs that are difficult to use decrease users' intentions to use a particular system and, ultimately, lower system use (Venkatesh et al. 2003). The perspective that complexity, difficulty, and effort exertion have negative impacts on behavioral outcomes is consistent with other models based on the Theory of Reasoned Action (Fishbein 1980) and the Theory of Planned Behavior (Ajzen 1991). This is echoed in practice, with marketing slogans such as that of Apple's "it just works" campaign that tout an extreme "ease of use" user experience.

Yet we should not forget about Archimedes and the joy he felt after solving the volume displacement problem; exerting effort to overcome a complex and difficult task can offer its own rewards and inspire loyalty in the use of the system. As a practical illustration, a recent magazine article suggests that when a person takes the time to learn how to repair household objects such as toasters or lamps instead of simply replacing them, that person can develop a "fierce" sense of attachment to those objects (Cooke 2014). In the article, the author described her experience at a "repair café," where she learned how to fix a broken lamp. After learning how to fix the lamp, she goes to a hardware store, picks up the required parts, and repairs the lamp at her home. Upon watching the bulb light up, she writes, she "felt a surge of pride—and a sudden, fierce attachment to the lamp" (Cooke 2014).

The stories appear to reveal a paradox between the well-established link between ease of use and behavioral intention (Davis 1989; Venkatesh et al. 2003) and the observation that the euphoric moment of solving a problem inspires continued use and attachment to an artifact (which we refer to as the "Eureka effect"). In this paper, we argue that while usage challenges are likely to harm a user's perception about ease of use, they may actually *increase* user satisfaction due to the Eureka effect if the user is able to successfully overcome those challenges.

This research in progress paper contributes both to IS theory and practice. First and most importantly, we push the boundaries of TAM to include the complicated effects of usage challenges. Specifically, we distinguish between three types of usage challenges: (1) Implementation Efforts, (2) Troubleshooting Episodes, and (3) System Maintenance. We suggest that while all three types of usage challenge harm perceived ease of use, the first two types may actually increase satisfaction under the right conditions. Our research also has significant implications for practice—particularly for consumer-facing support strategies. If successful problem solving can impact customer loyalty outcomes, support strategies should shift to a model in which educating and empowering the customer is prioritized over simply resolving his or her support ticket.

The remainder of this paper is organized as follows: First, we briefly summarize the existing literature on technology adoption and use, with an emphasis on the distinction between adoptive use and continued

use. We then apply theory to construct hypotheses in support of the Eureka effect that we establish in the paper's introduction. Although our primary focus at this stage of research involves refining the theory base and grounding the hypotheses such that the underlying idea is presented as persuasively as possible, we describe our future plans for data collection and analysis. We conclude the paper by discussing the limitations to our current conceptual model and presenting contributions and next steps.

Literature Review

One of the fundamental questions in the field of information systems asks why individuals use systems. User acceptance models are predicated on the idea that individuals have certain attitudinal reactions when confronted with technology and that these reactions shape their individual intentions to use that technology (Ajzen 1991; Davis 1989; Fishbein 1980; Venkatesh et al. 2003). TAM, the most well-known of these models, suggests that an individual's attitude toward adoption is a function of an individual's perceived usefulness and perceived ease-of-use of the system (Davis 1989).

Since Davis' original work in the late 1980s, the MIS research community has made significant progress in understanding user acceptance. While those models of user acceptance are effective in predicting behavioral intention to *initially* adopt a technology, they fall short in predicting post-adoptive, continuing usage behaviors. These "continuance" models are generally more applicable to modern organizational life (e.g., Kim and Malhotra 2005; Kim 2009). As technological tools grow ubiquitous in social and organizational life, users do not make adoption decisions in a vacuum. Instead, because of their familiarity with technology, they are more likely to test and experiment with different types of technology and then choose to adopt one that meets a set of requirements. This evolution in adoption thinking is reflected in modern theoretical models.

Expectation-based theories suggest that the initial use of a technology may force the user to adjust his or her initial perceptions and attitudes of the product. For example, under cognitive dissonance theory, if a person perceives a technology to be useful and, upon using that technology finds that it is not useful, the conflicting beliefs will cause cognitive discomfort until the user changes his or her beliefs (Cummings and Venkatesan 1976; Karahanna et al. 1999). Similarly, under expectation-confirmation theory, if the user's performance expectations are not confirmed by use, the user will become dissatisfied with the technology and discontinue subsequent use (Bhattacherjee and Premkumar 2004; Bhattacherjee 2001; Oliver 1980). The integrative framework of technology use (Kim 2009; Kim and Malhotra 2005) build on this work to show that explanations of technology use are constantly evaluated via the interactions between evaluations and behavior.

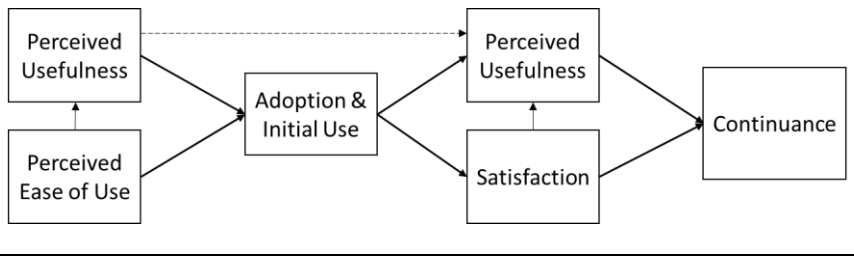

Figure 1. Previous Theoretical Understanding

Extant research reveals two important findings about the differences between pre-adoption and post-adoption beliefs. First, the role of attitudes and subjective norms differ greatly between initial and continued use cases. Karahanna et al. (1999) show that for pre-adoption use cases, subjective norms greatly outweigh an individual's own attitudes toward adoption. For post adoptive cases, however, the individual's attitudes toward the system strongly predict behavioral intention while normative considerations lose significance (Karahanna et al. 1999). Second, of those attitudes that predict post-adoptive behavioral intention, the user's satisfaction with the system is the strongest predictor of continuance intention (perceived usefulness is also significant, but with a weaker effect) (Bhattacherjee 2001).

A parsimonious representation of the findings of pre-adoptive and post-adoptive technology acceptance models is illustrated in Figure 1. It is important to note that the effect of ease of use on behavioral intention present in initial use TAM models becomes non-significant in post-adoptive use models (Bhattacherjee 2001; Davis 1989; Karahanna et al. 1999). Its non-significance in these models, however, does not necessarily imply that it is a theoretically meaningless construct in a post-adoptive use world. Both pre- and post-adoptive user acceptance models assume the linearity of ease-based constructs; the dominant thinking that underlies these models implies that all increases in effort exertion decrease perceived usefulness and lead to lower behavioral intentions.

While the continued use models represent a step forward for TAM, our research is designed to look for a Eureka! effect within a framework of technology use. Thus, the research question that guides this paper asks whether individuals that overcome usage challenges are *more* likely to continue using the technology than if they had not overcome those challenges due to the Eureka effect. This question moves away from cyclical changing evaluation attitudes over time toward a new liminal model of IS lifetime use.

Usage Challenges

The adoption and subsequent use of a new organizational information system is not always a smooth sailing process, particularly in a mandatory use context. Nearly any technology user can recall a time that extra, unexpected effort was required in the process of setting up or using a system. These challenges can come about in many ways in organizational life and, if unchecked, can impact satisfaction levels in users. For example, organizations may hire consultants to implement a new ERP system but face challenges that arise from breakdowns in transferring implementation knowledge from the consulting team to the client team (Ko et al. 2005). Similarly, the use of networked systems may require intermittent troubleshooting due to correlated failures within a software stack (Chen et al. 2011) or evolving compatibility or interoperability standards over time (Lyytinen and King 2006).

We suggest that usage challenges can be organized into three temporally identified types: implementation effort, troubleshooting episodes, and maintenance routines. Each of these usage challenges is initiated by an organizational prompt: implementation effort is initiated at the beginning of an IT implementation, troubleshooting episodes are initiated by unanticipated interruptions from within the system, and routine maintenance is initiated according to known routines established by the organization or the system. These usage challenges often occur at liminal points in the lifecycle of a system. Liminality, a concept originally used by cultural anthropologists to refer to the *process* of a social transition (Turner, 1964) has been applied to organizational research as a lens to study transitions and emergent phenomena (e.g., Henfridsson and Yoo, 2014; Howard-Grenville et al., 2011). In this paper, we use liminality to describe the evolution of an individual's attitundinal processes from the point at which the technology implementation is proposed and pre-adoptive perceptions take root to the various confirmation and disconfirmation events that affect the user's attitude toward the technology.

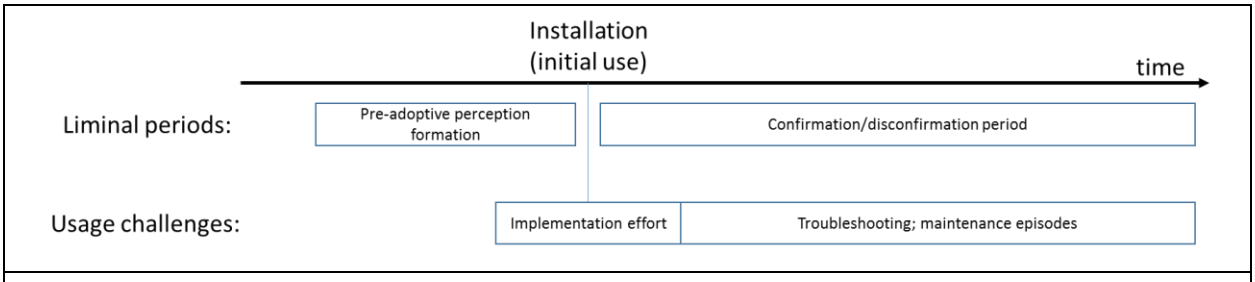

Figure 2: Usage Challenges by Liminal Period

In this case, implementation processes exist *in between* the pre-adoption and post-adoption periods. During this liminal period, a user has formed evaluations of usefulness and ease of use that caused him or her to *move toward* adoption but those initial evaluations may have been disconfirmed by some usage challenge. Figure 2 illustrates three types of usage challenges (implementation effort, troubleshooting episodes, and maintenance routines) and roughly plots them along a liminal event space, that includes the

production and confirmation (or disconfirmation) of a user's attitudes throughout the process of installation and use.

For example, in Figure 2, implementation effort occurs around the point at which the new system is installed, but before it is used. Because it has not yet been used, the user's expectations regarding the use of the product have not yet been disconfirmed. Thus, usage challenges may affect perceived ease of use like in *pre*-adoption models (Davis 1989; Karahanna et al. 1999) and user satisfaction like in *post*-adoption models (Bhattacherjee 2001). This is a fundamental assumption of our work: the temporal ordering of the various user experiences that help to confirm or disconfirm the user's attitude toward the technology matters a great deal and—in some cases—difficult-to-use technologies may result in increased intention to continue use—controverting the commonly-held logic of TAM.

In the remainder of this research in progress piece, we present our hypotheses as to the effects of implementation effort, troubleshooting episodes, and maintenance routines on perceived ease of use and user satisfaction to better understand the effects of usage challenges on continued use of technology.

Implementation Effort

As described in the illustrative example above, implementation effort refers to any usage challenges that take place in the installation process of the technology in preparation of initial use. Specifically, implementation effort occurs after the user's initial positive evaluations of the system, but before the user can use the system to truly confirm or disconfirm their initial evaluations. The cost-benefit paradigm on which acceptance models are predicated suggests that individuals choose among various strategies based on a cognitive tradeoff between the effort to employ the strategy and the quality of the result (Davis 1989). If a user encounters implementation effort prior to use, he or she may alter the initial cost-benefit analysis and decide that the system is no longer easy enough to use.

H1a: Implementation effort will negatively impact a user's perceived ease of use.

We hypothesize that the relationship between implementation effort and satisfaction takes an inverted U-shape. When implementation effort is very low, satisfaction is affected primarily by perceived usefulness and confirmation, as per expectation-confirmation theory (Bhattacherjee 2001; Karahanna et al. 1999). In other words, satisfaction is unaffected by the "lack" of implementation effort. However, as implementation effort increases, we believe that satisfaction *increases* due to the affective responses associated with building something new (i.e., the Eureka effect), up to a certain tipping point. In this case, the user has a positive evaluation of the system, struggles to implement it (like Archimedes in the Roman bath), but is successful without burning himself or herself out in the process. That user will feel the same spark of success and overall satisfaction will be higher than without that implementation effort.

The model of PC utilization includes an explicit focus on affective variables in acceptance models (Thompson et al. 1991; Triandis 1977). Successfully completing the implementation of a technology can constitute an affective experience in the workplace; users may feel as if they built something new and useful from the ground up. Affective events theory suggests affective reactions to these types of experiences can alter work attitudes and, ultimately, attitudinally-driven work behaviors (Weiss and Cropanzano 1996). Thus, successfully troubleshooting a system can inspire emotions such as pride in an individual's work. Weiss & Cropanzano (1996) argue that individuals respond to affective events in the workplace by forming attitudinal or behavioral responses. In this case, an individual may form an affective attachment to a system he or she helped build and install, resulting in higher levels of satisfaction.

Too much effort exertion, however, may cause satisfaction levels to fall precipitously. According to expectation-confirmation theory, satisfaction levels are formed as a result of users' assessments of perceived performance vis-à-vis their original expectations (Bhattacherjee 2001, p. 353). If the decision calculus between exerted effort and perceived performance drifts too far, satisfaction will fall. This inverted U-shape relationship is illustrated in Figure 3.

H1b: Implementation effort during system installation will impact satisfaction via an inverted U-shaped function such that satisfaction will be unchanged under conditions of low implementation effort; satisfaction will be improved under conditions of medium implementation effort; and satisfaction will be negatively impacted under conditions of high implementation effort.

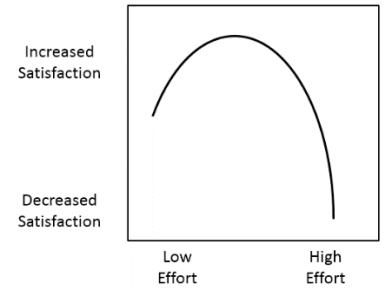

Figure 3. Hypothesized Effort-Satisfaction Curve (Described by Hypotheses 1 & 2)

Troubleshooting Episodes

Troubleshooting episodes refer to solving problems that occur during the continued use of a system. These problems are generally non-routine in nature, and are generally thought of as unpleasant surprises (e.g., hardware failure, software corruption, etc.). If a troubleshooting episode arises and it is not handled, the organization may face some level of performance degradation until it is. There is an inherent difference between a troubleshooting episode and routine maintenance (which is considered in the next section): a troubleshooting episode is focused on repairing and correcting a system in order to return it to original working order and maintenance routines are activities associated with keeping a computer system running and in-tune (Edwards 1984; Riggs 1969; Swanson and Dans 2000; Swanson 1976). Like implementation effort, troubleshooting episodes alter the cost-benefit paradigm of ease and, thus, ought to decrease perceived ease of use. After all, if use is interrupted by a troubleshooting episode that the user has to solve before returning to work, the user is going to find that the use of the system is no longer free from effort (Davis 1989).

H2a: Troubleshooting episodes will negatively impact a user's perceived ease of use.

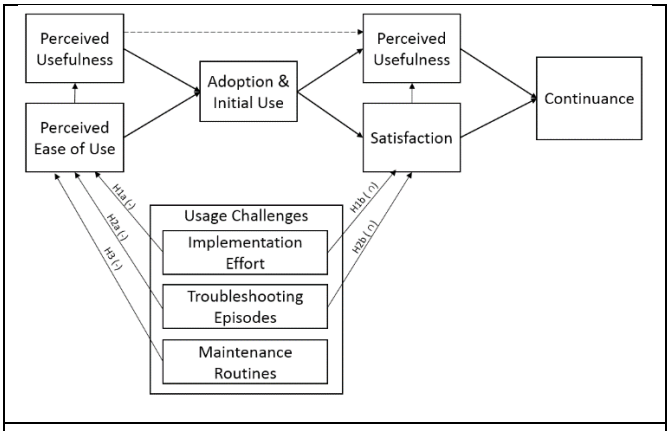

Figure 4. Theoretical Model

Additionally, also like implementation effort, we hypothesize that the relationship between troubleshooting episodes and satisfaction will take an inverse U-shape (as seen in Figure 3). Flow theory predicts that when users solve challenging problems that are well-matched to their skillset, they will enjoy the moment and also increase their skills, self-esteem, and personal complexity (Csikszentmihalyi and LeFevre 1989; Karahanna et al. 2006). Using this line of thinking, we expect the right amount of troubleshooting effort to be somewhat enjoyable to a user if they are able to successfully solve the problem (i.e., Eureka effect). Of course, if the problems are overwhelming, impossible to change, or exceptionally frustrating then we expect user satisfaction to suffer.

H2b: Troubleshooting episodes will impact satisfaction via an inverted U-shaped function such that satisfaction will be unchanged under conditions of low troubleshooting episodes; satisfaction will be improved under conditions of medium troubleshooting episodes; and satisfaction will be negatively impacted under conditions of high troubleshooting episodes.

Maintenance Routines

Maintenance routines refer to any *anticipated* service that needs to be performed on an information technology. Systems maintenance is a broad term related to activities associated with keeping a computer system running and in-tune (Edwards 1984; Riggs 1969; Swanson 1976). Unlike a troubleshooting episode, the maintenance routines are not caused by a system failure, but are preventative or cyclical and part of on-going care and upkeep of a system. Performing maintenance has been shown to negatively affect user opinions of a system, since it is seen as a chore by users (Palvia and Palvia 1999). Unlike implementation efforts and troubleshooting efforts, maintenance routines do not involve problem-solving opportunities for Eureka moments for the user. Therefore, we only expect maintenance routines to harm satisfaction via a negative impact in perceived ease of use. We summarize our three sets of hypotheses in Figure 4.

H3: Maintenance routines will negatively impact a user's perceived ease of use.

Proposed Methodology

In order to test these hypotheses, we will leverage user support websites and forums in order to seek out technology users that are experiencing challenges with a system. We believe the text of a user's post generally includes enough information about their situation to categorize it as either (1) implementation effort, (2) troubleshooting episode, or (3) maintenance routines. Follow-up surveys will be distributed to users to access their opinions toward the product (e.g., perceived ease of use and usefulness) and if a Eureka effect was experienced.

We also anticipate needing to develop scales to capture more information about the type of problem/challenge encountered, if a solution was reached, and if users felt any positive affect due to success. To this end—particularly given the complex u-shaped hypotheses—several pilot studies must be conducted. Additionally, it will be critical to measure controls such as gender, age, and voluntariness of use as previous research suggests that they represent significant moderating influences (Venkatesh et al. 2003).

Expected Contributions and Future Directions

This research is a work in progress and we are currently refining the theoretical model and planning potential methodologies and data collection strategies. However, we expect the exploration of the new usage challenges construct and the testing of the presented hypotheses to have the following impacts to theory and practice.

Contributions to Theory

The theorizing in this research in progress piece makes a number of contributions to theory. Our first theoretical contribution is reflected in the Eureka effect, as we seek to explore the complexity behind ease of use in technology use situations. We posit that the Eureka effect may be a mechanism which causes usage challenges to actually *improve satisfaction*. This mechanism may be related to the psychology observation that locus of control is important to users, and that co-creation causes buy-in. Though not present in most adoption models in the information systems field, locus of control was an important consideration in psychology as the theory of planned behavior evolved (Ajzen 2002). The concepts of locus of control and co-creation are important to people continuing medical treatment and exercise (Koo et al. 2006; Menec and Chipperfield 1997), education (Coleman and DeLeire 2003), and entertainment (Koo 2009).

Second, to our knowledge, TAM research generally does not disaggregate user expectations into various liminal periods based on what types of expectations would be developed and confirmed or disconfirmed at

a particular point in the history of that system's use. This level of granularity adds a new dimension to the contribution made by Karahanna et al. (1999) because it creates multiple worlds in which users must rely on *a priori* expectations or expectation disconfirmation or both.

While the role of TAM in understanding user behaviors is fairly well-trodden ground, we believe our exploration into the paradox between ease of use and the Eureka effect of usage challenges will grant important insights into how user satisfaction is created and maintained during continued use. As technology becomes more and more cheap and ubiquitous, switching-costs are often lowered. However, our proposed relationships may yield new understanding on how to create user loyalty and buy-in to technology.

Contributions to Practice

Conventional wisdom suggests that developers should make their products as easy to use as possible. Marketing slogans such as Apple's "it just works" echo this sentiment that users should have no usage challenges. However, we argue that the absence of any usage challenges eliminates the possibility of a boost to user satisfaction due to the pleasure of problem solving. If it always "just works" then the technology may become invisible to users, and they may not develop the same loyalty to the technology as the right amount of "co-creation" via usage challenges would have yielded.

Post-sales maintenance has long been recognized as an important part of technology development and delivery (Ives and Vitale 1988; Swanson and Dans 2000). While we are certainly not suggesting that troubleshooting episodes be purposely created, our proposed ideas do suggest that technology companies might leverage implementation efforts and troubleshooting episodes to their advantage. Perhaps implementation should not embrace the "it just works" mindset, but instead involve users in the implementation through set-up and customization processes.

Future Considerations

While this work is currently in very nascent stages, we suggest many avenues that should be considered as it progresses. First, usage challenges should be studied longitudinally. There is likely to be a very delicate tipping point between the point where satisfaction is increased by usage challenges and the point where satisfaction is harmed and the user considers discontinuance. The frequency and severity of the troubleshooting episodes should be considered. An ideal pattern of Eureka effects may be uncovered that maximizes customer loyalty. These patterns may also change depending on the life cycle stage of the technology. Previous work has suggested that users' realization of increased problems may signal end-of-life of the technology solution (Swanson and Dans 2000).

Training is another important, and often time-intensive, component to technology use. In one survey, training was considered to be the most disliked aspect of technology time costs (Palvia and Palvia 1999). However, teaching someone else software is often associated with positive affect changes about the material and strengthened "buy-in". Training time should be considered as a possible usage challenge in future studies.

In addition to the inverse U-shaped relationships having a delicate "tipping point," it is also likely that the tipping point is different for implementation efforts and troubleshooting episodes. In the first, the user has not yet experienced the technology and is still in a quasi-adoption state. This paper takes a liminality perspective on this threshold state, which enables theorizing above and beyond perspectives that analyze pre-adoption and post-adoption states as truly discrete. The tolerance of problems for people in this threshold state is likely to be different than an experienced user already committed to and using the technology. It is possible that a well-controlled experiment may be more effective at finding an effect—particularly given differing inflection points. As the data collection strategy begins to form, this type of design may prove fruitful to consider.

Conclusion

We have presented a set of hypotheses related to the possible beneficial effects on satisfaction caused by usage challenges. This is counter to the conventional wisdom that any usage challenges will harm adoption and usage behaviors by lowering a user's perceived ease of use. While we agree that perception

of the ease of use are likely to be lowered, we counter that the "right" amount of challenge can improve satisfaction via a surge of pride and euphoria nicknamed the Eureka effect.

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