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An Analysis of the Effect of Digital Badging on Workplace Self-Directed E-Learners' Achievement, Persistence, and Self-Regulation

Emma Awuor Agola
Old Dominion University, ndikna@gmail.com

AN ANALYSIS OF THE EFFECT OF DIGITAL BADGING ON WORKPLACE SELF-DIRECTED E-LEARNERS' ACHIEVEMENT, PERSISTENCE, AND SELF-REGULATION

by

Emma Awuor Agola
B.A. June 1997, University of Eastern Africa Baraton, Kenya
M.Ed. December 2004, Columbus State University

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Approved by:

Tian Luo (Director)

John Baaki (Member)

Helen Crompton (Member)

ABSTRACT

AN ANALYSIS OF THE EFFECT OF DIGITAL BADGING ON WORKPLACE SELF-DIRECTED E-LEARNERS' ACHIEVEMENT, PERSISTENCE, AND SELF-REGULATION

Emma Awuor Agola
Old Dominion University, 2020
Director: Dr. Tian Luo

Despite the advantages and increase in popularity of self-directed e-learning, this mode of learning is still reported to suffer from low voluntary enrollment rates, high learner dropout rates, as well as low retention of learning. Although there is a paucity of motivation research with regard to self-directed e-learning, a considerable number of studies identify shortfalls in factors related to learner motivation as the most prevalent factor contributing to these pitfalls.

The current study investigated the effect of digital badges, an extrinsic reward, on learning effectiveness, persistence and self-regulation in a corporate self-directed e-learning environment. The study employed an experimental between-subjects design with one independent variable, the opportunity to earn digital badges. The dependent variables for the study included learning achievement, learning retention, persistence to course completion, and self-regulation. Participants completed one required e-learning module and had the opportunity to engage with two elective ones. The experimental group had the opportunity to earn digital badges while the control group did not. The study sample (N=76) consisted of new or existing employees working in various roles in a corporate organization.

A series of Mann-Whitney U tests were performed to determine group differences in learning achievement, learning retention, persistence to course completion and self-regulation. The results of these analyses found significant median differences in all four dependent variables on the basis of group, suggesting a consequential relationship between the use of digital badges and the variables examined.

This study contributed to research on the use of gamification as a motivational strategy within the e-learning context. It also helped establish the impact of digital badge use on learning effectiveness and engagement in adult self-directed e-Learners.

Key terms: digital badges, motivation for learning, learning achievement, learning retention, persistence to completion, self-regulation, self-directed e-learning, workplace learning

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NOMENCLATURE

Achievement:	In the context of the current study, achievement refers to learners' posttest performance on a summative assessment.
Digital (learning) badge:	A visible indicator of an accomplishment, interest, or affiliation. It often contains a hyperlink that holds information on the context, meaning, process, and the result of the activity the digital badge represents.
E-learning:	A form of Web-based instruction in which the learner goes through instruction delivered via the Web.
Learning Management System (LMS):	A software application used for the delivery, tracking and reporting of learning activities and events.
Motivation for learning:	The internal impetus or aspiration that drives a learner towards a learning-oriented goal
Open Badge Ecosystem (OBE):	The architecture and API environment that connects the applications for issuing and displaying digital learning badges.
Persistence in E-learning:	The continuing action an online student takes despite the presence of obstacles.
Perceived Locus of Control (PLOC):	Perception of the cause or origin of a behavior
Relative Autonomy Index (RAI)	The relative autonomy index (RAI) is a measure of the motivational autonomy that expresses the extent to which an individual experiences coercive or internalized pressure to perform specific behaviors (Williams & Deci, 1996).
Retention:	The amount of learning recalled on a confirmative assessment after a long period of disuse
SCORM (Shareable Content Object Reference Model):	A specific format of constructing LMSs and e-learning content and LMSs to make information shareable across other SCORM compliant systems.
Self-Directed E-learning (SDEL):	A form of E-learning in which learners independently matriculate through web-based learning modules with minimal or no interaction with an instructor.

Self-regulation:	The extent to which learners are autonomous versus controlled in performing specific behaviors.
Volitional learning:	The voluntary pursuit of knowledge, skills and competencies for either personal or professional reasons.
Workplace learning:	The process of gaining relevant skills and knowledge for work-related tasks

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INTRODUCTION AND LITERATURE REVIEW

Introduction

The debate over the effectiveness of the use of extrinsic rewards to influence learning is well documented. Some researchers postulate that extrinsic rewards undermine intrinsic motivation for learning tasks (for example Deci, Koestner, & Ryan, 2001; Lombardi, Cavaliere & Cipollini, 2020; Shahid & Raza, 2015;), while others refute this assertion and even contend that the use of rewards may serve to enhance learners' innate passion under the right circumstances (Eisenberger, Pierce & Cameron, 1999; Hewett & Conway, 2016). Despite this controversy, the use of extrinsic rewards continues to grow, and has become even more widespread with the proliferation of serious gamification. There remains however, little empirical research to substantiate or disprove the efficacy of gamified extrinsic rewards such as digital badges in motivation for learning. This paucity of research is especially evident in the domain of workplace self-directed e-learning (Filsecker & Hickey, 2014).

Self-directed e-learning, which has accounted for a significant portion of corporate investment in recent years, has enjoyed a considerable increase in popularity according to some industrial surveys (SkillSoft, 2010; Wong & Sixl-Daniell, 2015). Accuracy Research (2017) reported that the global market value of self-directed e-learning resources was $107 billion in 2015. At the projected compound annual growth rate of seven percent, this market value is expected to increase to $325 billion by 2025. Organizations are increasingly recognizing this mode of learning as an essential asset due to its many benefits, which include, anytime/anyplace learning, just-in-time delivery of learning, cost-effectiveness, and self-management of learning (Cheng, Wang, Moorman, Olaniran, & Chen, 2012; Wang, Ran, Liao, & Yang, 2010).

In the present study, “self-directed e-learning” (SDEL) refers to web-based learning content that learners access through a learning management system (LMS) and complete independently without instructor guidance. In this environment, learners take complete responsibility for managing their e-learning without the involvement of peer learners or instructors (Kim & Frick, 2011). Although variations exist across organizations in models and approaches, SDEL typically includes three main types of training:

1. Formal training on a specific skillset required by an organization to ensure work is done according to specific standards. This type of training typically includes improvements in technology, new laws and regulations that pertain to a specific field or industry. Learners typically enroll in the training in order to earn or maintain a credential required by their employer in order to maintain their eligibility to work in the specific role.
2. Formal compliance training to ensure the safe and efficient operation of an organization. This type of training typically includes general knowledge on company history or products, quality initiatives such as guidelines and standards for internal processes, company policies on human relations such as diversity and inclusion, bias and harassment; as well as business soft skills such as customer service and conflict resolution. Learners typically enroll in the training in order to abide by the organization’s compliance requirements.
3. Informal employee training to acquire or improve one’s knowledge base or skillset. In this type of training, employees determine their need for learning, and choose topics that interest them and fulfill their self-determined learning requirements. The training is typically metric-free, with learners setting their own expectations around achievement. Being devoid of strict

timelines or formal checkpoints, it is completely self-paced. Learners typically enroll out of interest or a self-determined need to acquire knowledge or skills. The current study focused on engagement issues pertaining to the second and third types of self-directed e-learning (SDEL) identified here (formal compliance and informal employee training).

Despite its advantages (see Conkova, 2013; McNelis, 2014), SDEL in the workplace (SDEL) has suffered some major drawbacks, including low voluntary engagement rates (Martinez, 2003; Park & Choi, 2009), high learner dropout rates (Aparicio, Bacao & Oliveira, 2016; Carr, 2000), and poor learning outcomes as reported by workplace managers (Allen & Seaman, 2015; Hicks, 2000). Elective participation rates in this mode of learning are still meager (Martinez, 2003). The percentage of learners that voluntarily initiate learning in these contexts is minimal (Aparicio et al., 2016; McNelis, 2014). Even smaller is the number of those who subsequently persist long enough to complete the online modules in which they are enrolled (Carr, 2000; Cornell & Martin, 1997; Martinez, 2003). Previous studies report the dropout rate in these adult self-directed e-learning (SDEL) modules to be about 10-20% higher than that in traditional face-to-face courses (Ali & Leeds, 2009; Aragon & Johnson, 2008; Carr, 2000; Dalton, Manning, Hagen, Paul, & Tong, 2000). Research on the participation rates of Massive Open Online Courses (MOOCs), a form of SDEL, has also revealed significant decline as courses progress with reported completion rates being as low as three to six percent (Breslow, Pritchard, DeBoer, Stump, Ho, & Seaton, 2013; Jordan, 2014; Jung & Lee, 2018; Yang, Chen, & Jeng, 2010).

These issues do not apply to the first type of SDEL (formal training) listed above, as learners are typically mandated to enroll and matriculate through the training. Although enrollment and completion are also typically mandated in the second type (formal compliance training), this type of training is subject to poor learning outcomes, as learners typically seek to meet the very minimum of their employers' compliance requirements. Due to its volitional nature, the third type of training listed (informal training), suffers from low voluntary engagement rates as well as high learner dropout rates (attrition).

Previous studies have attributed issues concerning poor learning outcomes and high attrition rates in SDEL to low self-efficacy (Vilkas & McCabe, 2014) and poor self-regulated learning strategies (Broadbent & Poon, 2015). These studies also found correlations between these issues and critical thinking and time management (Broadbent & Poon, 2015). Practitioners and researchers alike have also come to understand that the underlying reasons that drive learners' involvement in an activity determine the quality of their learning outcomes as well as their likelihood of persistence to completion (Artino & Stephens, 2009; Broadbent & Poon, 2015). People who engage in activities that match their interests or meet their values tend to perform better than those who engage out of compulsion. Those who recognize the usefulness of an activity are more likely to participate in it than those who are agnostic towards it. A person's participation in an activity is therefore regulated by their underlying motivations for engagement.

Self-directed e-learning (SDEL) also appears to require a level of personal commitment that most learners do not have (Allen & Seaman, 2006). Trainers and educators have raised concerns that SDEL may not effectively facilitate "deep learning," and retention, particularly when learners lack the intrinsic motivation to acquire knowledge or skills from the technology-mediated setting (Martens, Bastiaens, & Kirschner, 2007). Gutierrez (2016), points out that adults especially, are notoriously short of motivation in these settings. She describes them as "skeptic, uninterested in learning new skills, and loathing to implement newly-acquired knowledge in practical scenarios."

A relatively novel learning environment, the issues encountered in self-directed e-learning warrant the exploration of novel solutions such as the use of digital badging as a motivational strategy. By the time this study was carried out, the application of external motivational manipulatives such as digital badges had been suggested but not adequately explored (Chauhan, 2014). Digital badges are becoming a common feature in many corporate learning management systems [LMS] (Chou & He, 2017; Denny, 2013), but the literature on their motivational capacities is in its infancy, requiring more empirical research (Antin & Churchill, 2011; Batalla-Busquets & Pacheco-Bernal, 2013). The present study sought to provide more insight into this consideration by investigating the effect of digital badge use on learning effectiveness, persistence, and self-regulation in a corporate self-directed e-learning environment. The following sections present the theoretical framework upon which the study was based, followed by a survey of existing literature on research related to this line of inquiry.

Literature Review

Extrinsic rewards have dominated the learning industry in the form of incentives and rewards such as gold stars, recognition and prizes, and in the form of disincentives such as poor grades and academic probation. Research on the effect of extrinsic rewards on motivation (Deci, 1971) led to the development of self-determination theory upon which this study is built. Self-determination theory addresses the motivational factors that drive people to persist in activities (Perryer, Celestine, Scott-Ladd & Leighton, 2016; Przybylski, Rigby, & Ryan, 2010; Uysal & Yildirim, 2016). The theory consists of four related sub-theories, including basic psychological needs theory, causality orientations theory, cognitive evaluation theory, and organismic integration theory. Collectively, these theories aim to provide a comprehensive explanation of human motivation. All four sub-theories are based on the contrast between autonomous (self-determined) and controlling (non-self-determined) forms of motivation. The current study was largely built upon the framework of two of the sub-theories – organismic integration and cognitive evaluation theories. The organismic integration sub-theory explains the process by which people internalize values and behaviors that they previously regulated from an external source. The cognitive evaluation sub-theory explains the effects of factors that promote or impede internal motivation for a task or activity.

Organismic Integration Theory

According to organismic integrated theory, humans have a natural tendency to assimilate environmental values and practices through a process called internalization. This process fosters the assimilation of values or behaviors that were previously regulated from an external source (Ryan & Deci, 2017). This theory explains how the underlying reasons driving an activity determine the persistence and effectiveness of the activity. An activity that is performed under external pressure can become so entrenched that an individual no longer recognizes their motivation for the activity as originating from an external source (Deci & Ryan, 2000). The more an externally regulated behavior is integrated into a person's value system, the more self-determined and sustainable the behavior becomes. In other words, a person's motivational orientation for an activity can progress along a continuum, moving from an externally regulated state on one end to a state of value integration that is indistinguishable from the intrinsically motivated state on the other end (see 'Table 1' below) (Parker, Jimmieson, & Amiot, 2010).

Deci and Ryan (2008) illustrated this theory using the example of academic achievement in child learners. Parents and teachers introduce children to the importance of academic achievement at an early age. A symbol of this academic achievement, good grades, quickly becomes the extrinsic reward that drives learning behavior in young learners. Over time, they begin to internalize this value and find themselves pursuing good grades in order to feel good about themselves or avoid feeling guilty for failing academically. They then evolve to the point where they recognize academic achievement as a key to unlock their career goals and begin pursuing it for this purpose. Finally, those who achieve the highest level of integrated regulation engage in learning activities because they truly value it as an end in itself. Thus, what began as an extrinsically motivated activity during childhood now closely resembles an intrinsically driven one.

Table 1

Motivation Continuum (Visser, 2017)

	Extent to which basic psychological needs (of autonomy, competence, and relatedness) are satisfied →					
Type of Motivation	**Amotivation** Feeling unable and unwilling, finding nothing interesting or important	**Controlled Motivation** "mustivation" Extrinsic Motivation		**Autonomous motivation** "wantivation" Internalized motivation		Intrinsic Motivation
Reason for behavior	**Inactivity** Passivity, avoidance, oppositional behavior	**External Pressure** Doing something because of external pressure (punishments, rewards, threats)	**Internal Pressure** Doing something because of internal "musts' and expectations	**Usefulness-driven** Doing something because of experienced usefulness, relevance	**Value-driven** Doing something because it fits with one's own deeply held values	**Interest-driven** Doing something because it is interesting or enjoyable
Effects	Insecurity, fear of failure, resistance, apathy	Tension, anxiety, little engagement and persistence, dissatisfaction	Feelings of guilt, shame, low sense of self-worth	Sense of volition, pleasure, energy, persistence, deeper learning, performing well, gratification		

Motivations for Learning in the Workplace. The motivational factors that drive employee learning can be distinguished from those that drive traditional student learning. To understand employee motivations for learning, it is prudent to consider their motivation for working in the first place, as it is likely to influence their approach to learning. Some employees for instance, claim to work primarily for the monetary remuneration while others identify other factors such as the need to feel productive as their motivation to work. Past research has identified three main approaches to learning (Kyndt, Raes, Dochy, & Janssens, 2013). Each of these approaches can be aligned to the main reasons people provide for working. Each approach also fits in with one of reasons for behavior identified on the motivation continuum of the self-determination theory (SDT).

Some people identify instrumental reasons as their main motivations for working. These include external factors that are separable from the work itself such as income, flexible working conditions or status and reputation. According to organismic integration theory, these individuals typically participate in learning for some extrinsic end such as getting a reward like pay or recognition or avoiding punishment such as forfeiting a bonus. Behavior driven by this type of external pressure is characterized by little engagement and low likelihood of persistence as well as a sense of tension, anxiety, and dissatisfaction. Some employees in this category have what researchers term as a surface approach to workplace learning (Kyndt et al., 2013). Others have what is called an achievement approach to workplace learning. Like surface learners, this approach is characterized by an intention that is extrinsic to the task. These employees are motivated by factors such as competition, good grades and an admirable public image (Kirby, Knapper, Evans, Carty, & Gadula, 2003). In the academic environment, these individuals are driven by the need to avoid failure. For workplace learners in this group however, motivation is not so much a matter of avoiding failure, as it is of achieving temporary extrinsic satisfaction (Kirby et al., 2003).

Organismic integration theory distinguishes between the type of extrinsic motivation that is external and that which is internal. Some employees are driven by internal rather than external pressure. The behavior of these types of people is governed by self-imposed internal expectations. Their behavior is often driven by feelings such as guilt over lack of participation, shame, or a low sense of self-worth that makes one question their qualification for a particular status or task. This type of employee has a surface-disorganized approach that is characterized by feeling dissatisfied with one's work environment, feeling overwhelmed, or struggling with a sense of incompetence when executing tasks (Bernsen, Segers, & Tillema, 2009)

Another category of employees who are driven by extrinsic motivation with a surface approach to learning consists of those who undertake training to gain the knowledge or skills they need to be able to perform their tasks. On the motivation continuum, these individuals include those who engage in behavior for its relevance to their needs. They are driven by the "usefulness" of the activity in question (Ryan & Deci, 2000b). They are more likely to persist in their behavior and acquire deeper learning that leads to good performance as a result. They also enjoy a sense of volition, pleasure, energy and gratification.

In addition to working for ubiquitous external rewards such as pay or income, some employees attest to being driven by their values or some intrinsic pleasure derived from specific work-related tasks. These types of employees participate in an activity or engage in a behavior because it fits with their own deeply held values. An accountant for instance, who embraces ethical business practices as a philosophy may be meticulous in learning how to efficiently check business accounts for discrepancies. Individuals in this group approach learning with an eagerness to understand the learning task. (Kyndt et al., 2013). As in the preceding "usefulness" category, this approach is characterized by a sense of volition, pleasure, energy, persistence, deeper learning, performing well, and gratification.

Akin to those driven by personal value are those whose work is driven by intrinsic interest in the tasks they undertake. The motivation of these types of people stems from inherent pleasure in certain aspects of their work, such as the autonomy it affords them or the satisfaction they derive from applying their skills. (Kyndt et al., 2013). These types of employees typically consider their growth and development as the most valuable aspects of work. They also tend to be more responsible for their jobs (Zhang, Zhang, & Li, 2018). As learners, these intrinsically oriented employees are typically concerned with developing their talent and potential. As such, they tend to participate in learning activities out of pure interest in the subject and content (Vansteenkiste, Lens, & Deci, 2006). Intrinsically motivated learners also experience a sense of volition, pleasure, energy, persistence, deeper learning, performing well, and gratification over their engagement in a task.

Cognitive Evaluation Theory

This sub-theory focuses on the effects of extrinsic rewards on intrinsic motivation. Depending on how a recipient interprets them, rewards can either undermine intrinsic motivation for a behavior, or provide feedback on one's competence in the behavior. The idea that extrinsic rewards undermine intrinsic motivation has been addressed widely. Social scientist and author Alfie Kohn for instance, boldly stated "… any approach that offers a reward for better performance is destined to be ineffective" (Kohn, 1999, p. 119). He identified the undermining effect of extrinsic rewards on intrinsic motivation as the primary reason incentive systems failed in K-12 education (Kohn, 1999). Extrinsic factors such as deadlines, imposed goals, surveillance, competition, recognition, and evaluations have all been found to undermine intrinsic motivation (Deci, 1971; Zhou, Zhang, & Montoro-Sanchez, 2011). These factors appear to antagonize people's sense of autonomy and rob them of their sense of enthusiasm and interest in the activities involved. Consequently, these factors become detrimental to creativity, cognitive flexibility, problem solving, and other outcomes associated with intrinsic motivation (Amabile, Goldfarb, & Brackfleld, 1990; Davis, & Singh, 2015; Lister, 2015).

One of the pioneer advocates of this school of thought is Edward Deci, who, in 2001, along with his colleagues, performed a meta-analysis of 128 studies on the use of extrinsic rewards. Their research revealed that the use of tangible rewards such as tokens and stars during tasks that their participants considered interesting had a negative effect on the intrinsic motivation of K-16 learners (Deci et al., 2001). Offering tangible rewards to students who were already intrinsically engaged in a task made their performance contingent on the reward and so reduced their chances of engaging in the task in the future without the reward.

Rewards can undermine intrinsic motivation by shifting one's behavior rationale. Once a reward is present, an individual who previously engaged in an activity for its inherent satisfaction may now persist in the behavior only as long as the contingency between the action and the reward exists. Once it is withdrawn, the person is likely to stop engaging in the behavior (Deci et al., 2001). This has been termed by researchers as the 'overjustification' effect, where the rationale for engaging in the behavior shifts from a focus on experiencing inherent satisfaction from the behavior itself to one on obtaining an external reward (Hoorens, Nuttin, & Herman, 2016). The person's perceived locus of control shifts such that their actions are now driven by an external event rather than an internal impulse (Heywood, Jirjahn, & Struewing, 2017).

An opposing body of research has demonstrated that the negative consequences of the use of extrinsic rewards could be negated under certain circumstances (Filsecker & Hickey, 2014; Gkorezis & Petridou, 2008). After conducting a meta-analysis based on 101 studies, Cameron and Pierce (1994) presented a compelling defense on the use of rewards. Their findings revealed a few insights: that some extrinsic rewards did not affect intrinsic motivation; that some such as constructive feedback actually facilitated the development of intrinsic motivation and that in these cases, rewarded participants reported higher intrinsic motivation than did the non-rewarded participants. Ryan (1982) carried out an experiment in which participants performed a task according to their own targets and received a reward in the end. Half the participants also received feedback for ‘doing well’ on the task. The study revealed that the reward plus feedback condition did not undermine participants’ intrinsic motivation for the task as much as the reward only condition did. When rewards are presented in such a way that they are perceived as being informative of one’s competence in an activity rather than an inducement to engage in it, they can actually enhance intrinsic motivation (Lim, Lee, & Bae, 2019; Ryan, 1982).When considered in light of the present study, one can hypothesize that a digital learning badge may promote intrinsic motivation if the learner interprets it as an informational agent rather than a reward that is contingent upon one’s behavior.

Extrinsic Rewards in the Workplace. Literature on the effect of extrinsic rewards on workplace learning is scant. As in the case of motivation for workplace learning, insights can be drawn from past research on the effects of extrinsic rewards on workplace performance. Organizations offer a variety of extrinsic rewards, including pay, benefit, and recognition programs to incentivize performance. Extrinsic rewards appear to have a positive impact on employee workplace performance in cases of simple and quantifiable tasks (Kuvaas, Buch, Weibel, Dysvik, & Nerstad, 2017). These types of rewards are often contingent upon an individual’s performance in tasks that are standardized and easily measurable (see Bareket-Bojmel, Hochman, & Ariely, 2017). Because of this, they are typically most effective in contexts where the measurable and attributable aspects of the work are good indicators of performance. Kuvaas, Buch, Gagne, Dysvik, & Forest, (2016) cite a study among salespeople in which the amount of money earned in contingent and salient incentives was found to be positively related to an increase in work effort over a two-year work period.

The effect of extrinsic rewards on employee performance has been found to be less clear in the context of cognitively complex or interesting tasks. These are often tasks that are already inherently motivating (Weibel, Rost, & Osterloh, 2010). Past studies revealed no correlations between tangible contingent incentives and qualitative tasks (Garbers & Konradt, 2014; Jenkins, Mitra, Gupta, & Shaw, 1998). When rewards are directly tied to the performance of tasks that are inherently satisfying, they do not increase extrinsic motivation or decrease intrinsic motivation enough to impact employee behavior (Deci, Koestner, & Ryan, 1999).

The effect of extrinsic motivators on workplace performance also appears to depend on the salience and employees' perceptions of the rewards themselves. Rewards that are meaningful to employees tend to have a greater impact on behavior (Dysvik, Kuvaas, & Gagne, 2013). In keeping with these findings, it would be rational to assume that cash rewards would always result in increased performance, as most people desire and appreciate financial rewards. In the same token, one would expect positive feedback and recognition to yield positive behavior change. However, much research has revealed that the effect of rewards on workplace performance is ultimately determined by employees' perception of the reward. Employees who perceive cash rewards as informational feedback for instance, display greater levels of motivation, and job satisfaction than those who interpret them as controlling or threatening (Landry, Forest, Zigarmi, Houson, & Boucher, 2017).

Overall, the effects of extrinsic rewards on work performance remain ambiguous, requiring more research (Kuvaas et al., 2017). One enduring concern over the use of extrinsic rewards to incentivize employee performance is the risk they pose in shifting one's focus from task engagement. Employees have been known to develop unbalanced preoccupations with incentivized tasks (Wieth & Burns, 2014). When tangible rewards are salient, employees tend to concentrate on the incentivized tasks and neglect the others (Gibbons, 2005). When this shift in focus occurs, the intrinsic enthusiasm that energizes a person to focus on performing a task well is compromised. This loss of intrinsic energy results in a surface level of task engagement in which the employee performs only the minimum task requirement needed to receive a reward (Kuvaas et al., 2017).

Extrinsic Rewards and Workplace Learning. Research on the application of extrinsic rewards to workplace learning remains scant and ambiguous. While Deci et al.'s (1999) assertion that tangible rewards undermine intrinsic motivation is echoed by many, extrinsic rewards have remained a staple in workplace environments where their benefits are well documented (Gil & Mataveli, 2016; He & Wei, 2009). Studies on knowledge transfer in the workplace has led researchers to argue, in keeping with cognitive evaluation as well as adult learning theories, that employees can only embrace learning when they perceive direct relevance and benefit from the learning activity (Gil & Mataveli, 2016).

As discussed before, extrinsic rewards are understood to have either a negative or a positive influence on intrinsic motivation, depending on their informing or controlling aspect. The informing aspect of an extrinsic reward increases a learner's perceived competence and strengthens their sense of self-determination. The control aspect on the other hand, decreases one's sense of autonomy and strengthens the perceived external control (Osterloh & Frey, 2000).

Research has revealed however, that not all rewards are created equal. Some rewards may have strong “informing” aspects in some contexts, and strong controlling aspects in others. Monetary rewards for instance, while very effective in incentivizing salespeople, have been found to be irrelevant to a person’s persistence in learning (He & Wei, 2009). It is important therefore, for learning practitioners in workplace settings to identify the types of rewards that can positively influence learning autonomy and persistence among employees.

Digital Badges

Digital badges are a relatively recent technological innovation with positive implications for motivation and learning engagement (Abramovich, Schunn & Higashi, 2013; Gibson, Ostashewski, Flintoff, Grant, & Knight, 2015; Jovanovic & Devedzic, 2015). Digital badges are a form of gamification, a term that Deterding, Dixon, Khaled & Nackle (2011) defines as “the use of game elements and design in a non-game context” (p. 10). Although these elements do not make up complete gaming experiences, they include rewards that encourage motivation and repeated behavior (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). Gamification is used in learning contexts to arouse learner interest and make the content more interesting. It is used with the purpose of motivating a learner to engage with the material longer than they might have done otherwise (Deterding et al., 2011; Sarangi & Shah, 2015). Gamification aims to influence feelings of autonomy, achievement and a sense of belonging through the use of extrinsic rewards such as badges, points, and levels (Richter, Raban & Rafaeli, 2015). The present study focused on digital badges.

A digital badge is a visible indicator of an accomplishment, interest, or affiliation. It often contains a hyperlink that holds information on the context, meaning, process, and the result of the activity the digital badge represents (Antin & Churchill, 2011; Gibson et al., 2015). In learning contexts, digital badges are mostly used as micro-credentials that represent and communicate learning achievements in digital environments. They can also be used to define and mark learning pathways. A learning pathway is the track or route a learner follows in order to achieve their learning goal (Abramovich et al., 2013; Gamrat, Zimmerman, Dudek, & Peck, 2014). Badges are used to encourage individuals to participate, act, or pursue tasks (Deterding et al., 2011). Due to their game-like features, digital badges are considered useful tools for incentivizing learners to engage with e-learning content (Elkordy, 2016). It is in this capacity as incentivizers that they were the subject of the present study.

A review of existing literature on how digital badges interact with learner motivation or engagement reveals a relatively limited number of studies, most of which are based on K-12 and higher education environments. Few of these empirical studies have been carried out in workplace settings (Dickey, 1999; Grant & Shawgo, 2013). Some of these studies support the notion that extrinsic motivators undermine the innate drive to engage in an activity. They postulate that digital badges are little more than extrinsic rewards that temporarily increase motivation before it dissipates once the desired ends are achieved (for example, Filsecker & Hickey, 2014; Tang & Hall, 1995). Others support the contrary opinion, which not only denies the undermining effect of extrinsic rewards on intrinsic drive; but also affirms their capacity to exert positive influence on the same. In other words, digital badges may have the potential to stimulate intrinsic drive for specific activities (for example in Yang, Chien & Liu, 2012). Both positions, however, are yet to be established through adequate empirical study.

Badge skeptics argue that rather than increase intrinsic motivation for learning, digital badges instead divert attention to the rewarding experience of earning badges (Chou & He, 2017; Hakulinen, Auvinen, & Korhonen, 2015). Giving rewards to learners for tasks that they already find inherently interesting reduces their overall motivation for those activities and thus undermines engagement. Abramovich et al. (2013) explored this notion in a study that investigated the impact of digital badges on the math ability of middle school students using an artificial intelligence tutoring program. The study used digital badges as rewards and required participants to practice math skills for 20 minutes daily for a month. Results revealed that the more badges students earned, the less concerned they were about their performance. It appeared that their focus shifted from the quality of their performance to the quantity of digital badges earned.

Hakulinen et al. (2015) referred to this phenomenon as the “presenter’s paradox,” where the use of an external motivator such as a reward inadvertently sends the message that the activity itself is not exciting and therefore requires an external reward to act as a motivator. Based on this premise, the use of digital badges to motivate self-directed e-learning in the workplace would inadvertently undermine learners’ inherent interest in the learning activity. The use of digital badges would shift their focus from the activity itself to the reward of receiving a digital badge. Some of the learners would maintain interest only as long as the digital badges were available for the earning while others would likely take shortcuts, skipping a lot of the learning content in order to meet the goal of earning their digital badge. The implicit message passed on to the learner by the use of digital badges in this case would be that the learning activity was not interesting in its own right (Deci et al., 1999). The few studies cited in this line of inquiry were based on K-16 learning contexts. At the time of the present study, little research had been carried out on the undermining effect of digital badges in workplace self-directed e-learning contexts.

Badge proponents advance the opposing argument, citing studies that revealed positive correlations between digital badges and constructs such as learning engagement, participation, achievement and performance. Wardrip, Abramovich, Bathgate and Kim (2014) found that badges can promote interest-based learning by incentivising learners to engage in self-directed learning processes. For two years, the researchers investigated a badge system designed to guide middle-school students through the pursuit of a variety of 21st century skills. Each skill was represented by a digital badge. Learners were given the opportunity to choose the skills that they valued such as, “how to collaborate with peers” or “information literacy”. Participant interviews revealed that the use of digital badges to exercise choice motivated learners to complete their learning pathways (Wardrip et al., 2014; Abramovich & Wardrip, 2016)**.**

Elkordy (2016) explored the impact of a digital badge intervention on the learning of STEM content among high school students from an underserved demographic population. The mixed methods study assessed whether the use of digital badges to engage, guide and assess learning activity would influence learners’ measures of motivation. Each badge represented a specific learning objective that required the submission of evidence to demonstrate mastery. The majority of students reported that the specific use of the badges to scaffold their learning and the requirement to submit evidence to demonstrate learning enhanced their experience significantly. Findings revealed statistically significant increases in learner self-efficacy, self-regulation, and perceived competence.

Denny (2013) also conducted a large scale (n>1000) randomized, controlled experiment on the impact of digital badges on learning engagement using an online learning medium called PeerWise. Learners were asked to author and share exam-style questions relevant to course content using the medium, which also allowed them to answer questions from other learners.

Half of the students were given access to a badge system in which they could earn badges for their contribution and activities while the other half were not. The findings of the study indicated a positive impact of badges on learners' levels of participation. The use of badges was found to increase the quantity of contributions without decreasing their quality.

Chou and He (2017) examined the effect of digital badge use on learner participation and interaction in a graduate program for teacher education. Digital badges were issued to students for contributions to quality class discussions in courses with two different pedagogical orientations: read-write-reflect-comment and activity-based design. Their findings revealed that digital badges were more effective in encouraging learner participation and interaction in the read-write-reflect courses than the activity-based ones, which were already highly interactive and therefore inherently motivating.

Another study by Anderson, Huttenlocher, Kleinberg and Leskovec (2014, May) investigated the impact of digital badges on learning engagement within Massive Open Online Courses (MOOCs), a form of self-directed e-Learning (SDEL). Their findings included an observed increase in course participation in three badge-integrated MOOCs. In these courses, learners earned badges through online behavioral contributions such as answering questions, asking questions, or voting on answers. The present study's outcomes revealed that the use of digital badges was an effective way to motivate learner engagement. It also revealed, however, that the type of course participation (such as answering or asking or voting questions) that the badge system incentivized did not always require as much cognitive effort as other types of participation, such as engaging in meaningful dialogue. The effect of the digital badge use appeared to reduce once participants internalized the learning behavior enough to draw motivation from within themselves.

Digital Badges and Workplace Learning Outcomes. Workplace learning designers have recently began to incorporate gamification elements with the hope of increasing participation, persistence, and knowledge transfer (Richter et al., 2015). Learning practitioners with experience in the use of serious gaming postulate that games can encourage employees to complete training tasks by rewarding them with gamification elements such as leaderboards and digital badges (Robb, 2012).

Many organizations have implemented the use of digital badges as credentialing systems for workplace learning or incentivizers of participation in learning. LiveOps Inc., an organization that runs virtual call centers, developed game based elements to help improve the performance of its 20,000 call agents. The incentive program awarded badges and points for tasks such as keeping calls brief and closing sales. Since the inception of the rewards program, the company experienced a 15% reduction in call time and an 8-12% increase in sales (Silverman, 2011). In another instance, the Learning Technologies Unit at the University of Washington (UW) implemented a skill-based promotion system using digital badges. Badges were awarded for specific activities and for achieving mastery and expertise on a skill set. As a result, the program reported increased motivation for learning among their staff members (Botra, Rerselman, & Ford, 2014). More research is needed to explore the effectiveness of badges as a motivational strategy in the context of organizational learning.

Recent research findings reveal that digital badging may have a significant role to play in encouraging sustainable learning by increasing learner autonomy and competence (Randall, Harrison, & West, 2013). The use of digital badges for gamification shows the promise of influencing lasting behavior change among workplace learners (Hamari, 2015). The present study sought to draw conclusions on the effect of digital badges on learning effectiveness, including achievement and retention, as well as persistence, and self-regulation in the context of workplace self-directed e-learning (SDEL). The following sub-sections consists of a discussion of relevant literature related to each of the constructs involved in the study.

Learning effectiveness (Achievement and Retention)

In the context of this study, achievement refers to learners' performance on a summative assessment (Elliot & Harckiewicz, 1994). Retention is defined as the amount of learned information recalled on a confirmative assessment after a long period of disuse (Semb & Ellis, 1994). Achievement and retention are usually determined through the processes of assessment and evaluation. Different types of evaluation, such as summative assessments are used to measure learning gains and to identify deficiencies that need improvement (Yildirim, Kaban, Yildirim, & Celik, 2016).

Backed by early philosophers such as John Dewey, Edgar Dale and Jerome Bruner, experiential learning advocates posit that learning achievement an retention can be increased by balancing abstract learning experiences with less abstract ones that are memorable, meaningful and practicable (Garrett, 1997; Jin, Kim, & Baumgartner, 2019).

Extrinsic Rewards and Learning Achievement. Under cognitive evaluation theory, rewards may or may not undermine intrinsic motivation for specific activities. Both possibilities have been significantly explored in research. There still is however, a lack of adequate empirical inquiry on the direct effect of extrinsic rewards on learning achievement and retention.

Results from some previous studies have revealed that extrinsic rewards can impair performance in any activity that requires deep concentration, resourcefulness or creativity (Cokley, 2003; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Studies on gamified learning have revealed that gamification elements such as digital badges appear to have a positive effect on academic achievement. Sheldon (2012) reported an experiment in which a high school biology course was gamified. Before gamification, 62% of students enrolled in the course held a grade of D or higher. This percentage went up to 98% after the course was gamified. Similarly, 10% of the students held a grade of A or B before gamification compared to 36% after the course was gamified (Sheldon, 2012). In a separate study designed to investigate the effects of gamification on learning, Dominguez, Saenz-De-Navarrete, De-Marcos, Fernandez-Sanz, Pages, & Martinez-Harraiz (2013) compared the performance of learners in a gamified environment with to those in a non-gamified environment. They reported better learner performance in the gamified learning environment as compared to non-gamified one. These findings corroborate those in a few other studies that found a positive correlation between the use of digital badges and increased academic achievement among K-12 learners (Davidson & Goldberg, 2009; McDaniel, Lindgren & Friskics, 2012; Yildirim et al., 2016).

There is considerable agreement that achievement and long-term retention in learning can be improved by increasing the level of learner motivation (Urdan & Schoenfelder, 2006). Given the paucity of studies on the correlation between extrinsic rewards and learning outcomes, this area of research would benefit from additional empirical inquiry.

Persistence to Completion

Persistence in the context of this study refers to the ability to continue with learning tasks associated with an e-learning module despite any frustration, obstacles, or competing goals that may occur in the process (Rovai, 2003; Jung & Lee, 2018). As mentioned before, self-directed e-learning has been plagued by high learner dropout rates, making persistence an important object of research in the field.

Persistence is commonly measured using behavioral indicators such as the quantity of course content a learner engages with (Jung & Lee, 2018). In an e-learning module, this likely includes the number of videos watched, the number of e-learning slides visited, the number of quizzes taken and the number of tasks completed. Most learning management systems (LMSs) have progress markers that track a learner's activity on all elements of a course. The LMS combines the information into a cumulative percentage that represents the learners' overall level of progress.

Extrinsic Rewards and Persistence. The research on the correlation between extrinsic rewards and persistence is scarce (Vansteenkiste et al., 2004), with some researchers suggesting game-based learning as a possible solution to counter attrition in self-directed e-learning (Moreno-Ger, Burgos, Martinez-Ortiz, Sierra, & Fernandez-Manjon, 2008; Parker, 2003). This recommendation is based on the positive effects of gamification on motivation (Parker, 2003).

Few empirical studies on the impact of a game-based approach on learners' persistence exist. Imbellone, Marinensi, & Medaglia (2015) carried out an empirical study that investigated the effect of gamification on persistence among e-learners. They enrolled 47 learners in a gamified course and monitored the rate of attrition. Of the 47 learners that enrolled for the course at the beginning, only three dropped out, revealing a much lower dropout rate than that of the average non-gamified e-learning course. This is in keeping with the notion that digital gaming increases the level and quantity of engagement, which in turn positively influences persistence (Moreno-ger et al., 2008). In a separate study, Barata, Gama, Jorge and Goncalves (2013) reported similar results in their study in which a blended (face-to-face and online) engineering course was used to measure the effect of gamification on learning engagement and satisfaction.

The course had suffered low attendance, very little participation in online activities and a lack of engagement with the course's reference materials. The study was carried out over two years, during which the course was administered to learners once each year. Game elements were only added to the course in the second year, during which the researchers added digital badges, leader boards and a points system. Several significant differences were observed between the non-gamified and gamified course years. A significant increase in the total number of student downloads and participation through discussion was observed. Learners reported higher levels of activity continuance for the gamified version of the course.

In these studies, extrinsic rewards or expectations appeared to have played a role in promoting learner continuance by virtue of encouraging participation (Alfes, Shantz, Truss, & Soane, 2013; Seifert, Chapman, Hart, & Perez, 2012). Other studies have reported that pairing participation with some sort of incentive or reward served to increase participation, in some cases quite significantly (Cawley & Price, 2013; Gingerich, Anderson, & Koland, 2012). Studies such as these are still scant however, and more research is needed on the effect of digital badge use on persistence to completion in workplace learning.

Self-Regulation

According to self-determination theory (SDT), behaviors vary in their range of autonomy or control. Autonomously regulated behaivor is experienced as volitional, enjoyable and interesting, while controlled behavior is the object of external or internal pressures or demands such as guilt avoidance. Self-regulation in the context of this study is the extent to which learners' behaviors are self-initiated and managed versus the extent to which they are externally initiated and controlled (Ryan & Deci, 2000). Zimmerman (2008) identifies it as the internal drive that underlies the agency and initiative taking of an individual as they take control of and regulate their activities. The totality of the concept is represented in the SDT motivation continuum that displays the reasons that drive behavior. These can range from external pressure, internal pressure, usefulness, value or interest. The higher up in the scale, the more self-regulated, self-determined, and autonomous a person is.

Support for a possible positive correlation between extrinsic rewards and self-regulation however, is found in the organismic integration (OIT) theory of self-determination. A learner may initially engage in a certain behavior for an extrinsic purpose such as to earn recognition or avoid punishment. However, as the learner identifies with the value of the activity, the behaviors associated with it are regulated, eventually becoming a part of the learner's self. This process of internalization and integration produces regulated behavior that can vary from passive compliance to active commitment (Zimmerman, 2008).

Self-regulation is commonly measured using self-rating empirical instruments. Studies based on self-determination theory typically use variations of the Self-Regulation Questionnaire (SRQ –A or SRQ-L) (Ryan & Connell, 1989) as a measure of the extent to which an individual's behavior is autonomous or controlled. The SRQ consists of questions that inquire the reasons behind a learner's engagement in a learning activity. The reasons include five purposes for behavior engagement, ranging from external pressure, internal pressure, usefulness, value or interest. The reasons identified are then used to determine the learners' style of regulation for the specific activity. Learners whose average responses lean toward external and internal pressure are considered primarily control-regulated while those whose reasons are driven by usefulness, value or interest are considered primarily autonomy-regulated. (Deci & Ryan, 2000; Niemiec & Ryan, 2009). The different levels of self-determination result in different levels of behavior regulation and outcomes. In light of the present study, it would be prudent to identify how learning effectiveness and persistence manifest at each level of behavior integration referenced in self-determination theory.

Intrinsic Regulation. The highest level of self-determination on the motivation continuum is “Intrinsic Motivation.” This level of integration is characterized by a natural tendency to seek and embrace challenges, to explore and assimilate knowledge, and to develop mastery (Ryan & Deci, 2000). When an individual finds a particular activity intrinsically motivating, he or she engages in it because it is interesting or enjoyable. Previous research demonstrated strong correlations between intrinsic motivation and active engagement, exploratory behavior, and learning continuance (Niemiec & Ryan, 2009). This level of engagement and self-determined behavior has have been associated with optimal performance (Deci & Ryan, 2008). This has also been proven true in the context of self-directed learning where intrinsically motivated learners have been found to display more learning gains than their counterparts with lower levels of motivation (Stewart, Waight, Marcella, Norwood, & Ezell, 2004).

This can be applied to the example of an IT developer who enjoys computing even when outside of work. This person is likely to demonstrate high achievement levels in an e-learning course on a new software update and persist to completion due to her intrinsic interest in the subject. Having had a significant amount of prior knowledge to add onto (Khader, 2015), she is also likely to retain most of her newly acquired knowledge for a long time.

Extrinsic Regulation. Most learners engage in learning activities that they do not find interesting enough to derive inherent satisfaction. As such, they often require additional incentives to motivate their engagement in activities that are not immediately interesting (Reeve, 2002). The question of how learners acquire motivation to engage in uninteresting activities and how this motivation affects learning outcomes and persistence has been the subject of previous motivation research (Ryan & Deci, 2000).

The integrated level of regulation on the motivation continuum represents the most internalized, autonomous, and self-determined form of extrinsic motivation. As far as behavior and learning outcomes go, this level shares many characteristics of intrinsic motivation. Integrated regulation however, is still a form of extrinsic motivation because a person engages in the behavior for some instrumental value other than solely for the inherent enjoyment and satisfaction with the activity itself. Integrated regulation has been associated with lower dropout rates, higher cognitive engagement and effort, higher quality behavior and better learning outcomes (Reeve, 2002; Niemiec & Ryan, 2009). An IT developer who works passionately on an assignment for an e-learning course on a software update because she deeply cares about the potential of technological innovation in the improvement of human lives falls in this category. Her passionate engagement is likely to be reflected in her achievement and retention levels, as well as her likelihood to complete the course.

When someone engages in an activity due to its relevance or usefulness for a particular end, their behavior is less internalized than the integrated level and they are operating under identified regulation. At this level, an individual begins to identify with the value of a behavior, making it a part of his or her identity (Ryan and Deci, 2000). An IT developer who pays increased attention to his e-learning course on the latest software update because he recognizes its value and usefulness as it relates to his career aspirations falls into this category. Studies reveal that this level of integration is related to better performance and higher rates of course completion because the associated behaviors have been endorsed by the self.

Benware and Deci (1984) carried out an experiment to determine how identified motivation affected achievement. They had two groups of college students learning about the machinery of the brain for three hours. Half of the students were told they would be assessed and graded on their learning, while the other half were told that they would use the material to teach others on the same topic. After the three hours, the researchers assessed the students' intrinsic motivation using a questionnaire. Results revealed that those who expected to be tested were less intrinsically motivated than those who learned in order to teach the material. The latter group also displayed a significantly better conceptual understanding of the material than their counterparts did. The researchers concluded that the idea of learning the material in order to teach others made it meaningful to the students. It imbued them with a sense of purpose, which in turn, served to stimulate their intrinsic interest for the learning activity.

Prior to the identified level of behavior regulation on the continuum is introjection. Introjected behaviors are performed in response to internal pressures such as guilt, shame or anxiety (Niemiec & Ryan, 2009). At this level, people engage in activities because of some internal expectation they have placed on themselves. Ryan and Deci (2000) identify ego involvements as a common form of introjected regulation. When one's self-esteem is contingent on their performance in an activity, they are likely to behave in certain ways in order to enhance or maintain their feelings of self-worth. In this case, the IT developer who works mainly to earn a living remains virtually uninterested in the domain of software development. She may, however, invest a little more effort in meeting the learning requirements of the e-learning course in order to avoid feeling guilty of not being a good professional, or because she would feel proud of herself for completing the course before her peers. Her learning outcomes are also likely to reflect this level of effort.

At the left end of the motivation continuum is external regulation, which is the least autonomous and self-determined form of extrinsic motivation. At this level, people engage in activities in order to get a reward or avoid punishment or in response to a threat. Externally regulated behaviors have been associated with lower learning outcomes and higher risks of dropout (Ryan & Deci, 2008) because actions performed solely to earn a reward or avoid a punishment do not align with one's integrated sense of self. If the IT developer referenced above chose his career primarily as a means to make a living without any particular interest in computing, he may engage in the e-learning course on a new software update solely to receive recognition from peers, or to avoid being placed on a professional development plan. This may negatively affect his learning outcomes and course progress as he strives to do the very minimum to earn a reward or avoid punishment.

Digital badges can be perceived as extrinsic rewards since they are used as rewards to incentivize behavior. It has been suggested however, that earning badges indicates competence and promotes autonomy. This in turn, can motivate greater participation and facilitate the internalization of behavior in some settings (Cavusoglu, Li, & Huang (2015).

Purpose Statement

The concept that extrinsic rewards undermine intrinsic motivation for learning tasks is well grounded in research. Previous studies have revealed that the use of extrinsic rewards spawns a loss of interest in a learning task once the desired end, the reward, is achieved. In self-directed e-learning, learners have been known to not only skip learning material in order to advance to course sections directly connected to earning the reward, but also to engage in the minimum activities required to earn the reward. The literature, however, documents findings of researchers who have refuted the universality of this assertion. These researchers contend that the use of rewards may serve to enhance learners' innate passion for learning under the right circumstances. According to cognitive evaluation theory, it is possible for extrinsic rewards to promote learning engagement when perceived as vehicles of constructive feedback rather than non-communicative symbols.

Self-regulation is a key contributing factor to a learner's initiative to enroll in an online learning module. It is also an important determinant of the learner's likelihood of completion as well as the quality of their learning outcomes (Nota, Soresi, & Zimmerman, 2004). Organizations are realizing that self-regulated learners must be intrinsically motivated to reach a high level of success with e-learning programs, as it requires learners to take personal responsibility for their own learning. Organizations cannot assume that all employees are naturally intrinsically motivated and must find ways to develop or enhance that motivation (Shimazu, Schaufeli, Kubota, & Kawakami, 2012).

Drawing from Knowles's principles of adult learning (Knowles, 1984), workplace e-learning is considered most meaningful when learners can identify its applicability to their work-related learning needs. Unlike other extrinsic rewards, digital badges provide specific feedback and guidance, and can therefore be designed to focus on specific work-related skills. In this sense, one can hypothesize that digital badges can positively impact the adult workplace learners' needs.

The present investigated the effect of digital badge use on learning effectiveness, including achievement and retention, as well as persistence, and self-regulation among adult e-learners in a corporate self-directed e-learning environment. An experiment was carried out in which half the study sample had the opportunity to earn digital badges during a learning event while the other half did not.

Drawing from the theoretical underpinnings that shape the study and the previous empirical evidence, the present study was guided by the following research questions and hypotheses:

RQ1: What effect, if any, does the application of digital badges have on adult E-learners' learning achievement as evidenced by average posttest scores?

H1. Learners in the experimental condition will achieve higher scores on the summative posttest than those in the control group. This hypothesis was elaborated from Sheldon (2012); Davidson & Goldberg (2009).

RQ 2: What effect, if any, does the application of digital badges have on E-learners' learning retention as evidenced by their retention test scores?

H2. Learners in the experimental condition will achieve higher scores on the retention test than those in the control group. This hypothesis was elaborated from Sheldon (2012); McDaniel et al. (2012).

RQ3: What effect, does the application of digital badges have on adult E-learners' persistence as evidenced by their average course progress?

H3. Learners in the experimental condition will engage with a greater percentage of total course material than those in the control group. This hypothesis was elaborated from Imbellone et al. (2015).

RQ4: What effect, if any, does the application of digital badges have on adult E-learners' behavioral regulation as evidenced by their average relative autonomy index (RAI)?

H4. Learners in the experimental condition will display higher levels of autonomous regulation than those in the control group. This hypothesis was elaborated from Deci & Ryan (2008); Niemiec & Ryan (2009).

Significance

A study investigating the effect of digital badge use on learning effectiveness, persistence to completion and self-regulation is important on multiple levels. First, the study's findings can enhance the foundational knowledge that workplace-learning designers need in order to build strategies to increase the quantity and quality of employee engagement with self-directed e-learning. By increasing engagement in self-directed e-learning, organizations could potentially see a measurable return on investment (ROI) where their content libraries are concerned.

The findings of the study can also be cited by individuals in any organization seeking justification for budgetary proposals related to e-learning resources. The significant financial investments committed to e-learning resources are often in danger of being considered wasteful when learning resources are not impactful or effective. Moreover, when the problem of employee engagement is addressed, the demand for well-designed effective e-learning will rise, as will the capacity to evaluate good training before investing millions in it. This study also contributes to a growing body of research on self-determination and the effects of rewards on intrinsic motivation. It extends the literature on the motivational capacities of digital badges, an area that is still lacking in adequate research.

Chapter II

METHOD

Participants

The present study was carried out at a not-for-profit regulatory organization with employees situated across seven cities on the Eastern coast of US. The study sample (N=76) consisted of employees in various roles across the organization, with a company mandated obligation to complete a specific e-learning course requirement. All participants were college graduates who had had experience with self-directed e-learning content using the company's LMS platform within the preceding year. None of the participants had previously enrolled in or completed any of the additional volitional e-learning content used for the study. The sample included male and female employees whose age, gender and years of professional work experience was used to provide more insight on the experimental findings. Participants submitted a consent form to allow the researcher to collect and use their data for research (Appendix B). Participants who chose to participate received a reward based on the organizations' existing employee incentive program. Participants' identities were kept confidential in all the reports generated.

Research Design

The study employed an experimental between-subjects design with one independent variable. The independent variable (IV) was the opportunity to earn digital learning badges. The dependent variables (DV) for the study included learning achievement (DV1), learning (knowledge) retention (DV2), persistence to course completion (DV3), and self-regulation (DV4). Participants in the study sample (N=76) were randomly assigned to one of two groups using a free online random number generator (https://www.randomizer.org): an experimental group with the opportunity to earn digital badges (Group A: N= $X/_2$), and a control group without the opportunity to earn digital badges (Group B: N= $X/_2$).

Participants accessed the organization's LMS platform to complete their required course assignment. During the three-week testing/experimental period, participants only had access to three courses on the LMS platform. These included the required e-learning module as well as two additional modules (see instructional materials and resources below). Unlike the required course, completion of the two additional courses was completely volitional.

The effect of digital badge use on learning achievement (DV1) was determined by comparing the experimental groups' summative test (Appendix C) performance on the required e-learning module to the control groups' performance on the same. The groups' average summative test scores were calculated and compared to see if there is a significant difference between them. The effect of digital badge use on learning retention (DV2) was determined by comparing the experimental groups' performance on a knowledge retention test (see questions in Appendix C) to that of the control group. The effect of digital badge use on persistence to completion (DV3) was assessed by comparing the percentage of total course content completed by each group at the end of the three-week experimental period. The effect of digital badge use on self-regulation (DV4) was determined by comparing the average relative autonomy index (RAI) of the experimental group to that of the control group at the end of the experiment. The relative autonomy index (RAI) is a measure of the motivational autonomy that expresses the extent to which an individual experiences coercive or internalized pressure to perform specific behaviors (Williams & Deci, 1996). Essentially, the RAI is based on the Organismic Integration Theory's 'motivation continuum.' It combines the major reasons people act on a specific activity into a score. Learners with a high relative autonomy index (RAI) in a specific domain are more likely to initiate and persist in learning activities than those with low RAI in the same domain (Black & Deci, 2000).

Materials

Digital Badge System

The digital badges used for this study were designed using a levelled approach. The system had bronze level badges, silver level badges, and gold level badges. To earn a bronze level badge, one had to complete the requirements of a single e-learning course successfully. This designated a beginner's level of mastery. Multiple courses relating to the same theme or subject could be grouped together and assigned a silver level badge, which denoted an intermediate level of mastery in the domain. Similarly, the gold level badges represented an advanced level of mastery in a particular domain or subject area. Participants in the experimental group of the present study had the opportunity to earn four different badges, including three bronze level badges that made up a silver level badge when grouped together (Figure1). Participants were able to earn a badge for each of the courses offered, including the required e-learning module and the two volitional (elective) modules.

Figure 1

Digital Badge Images

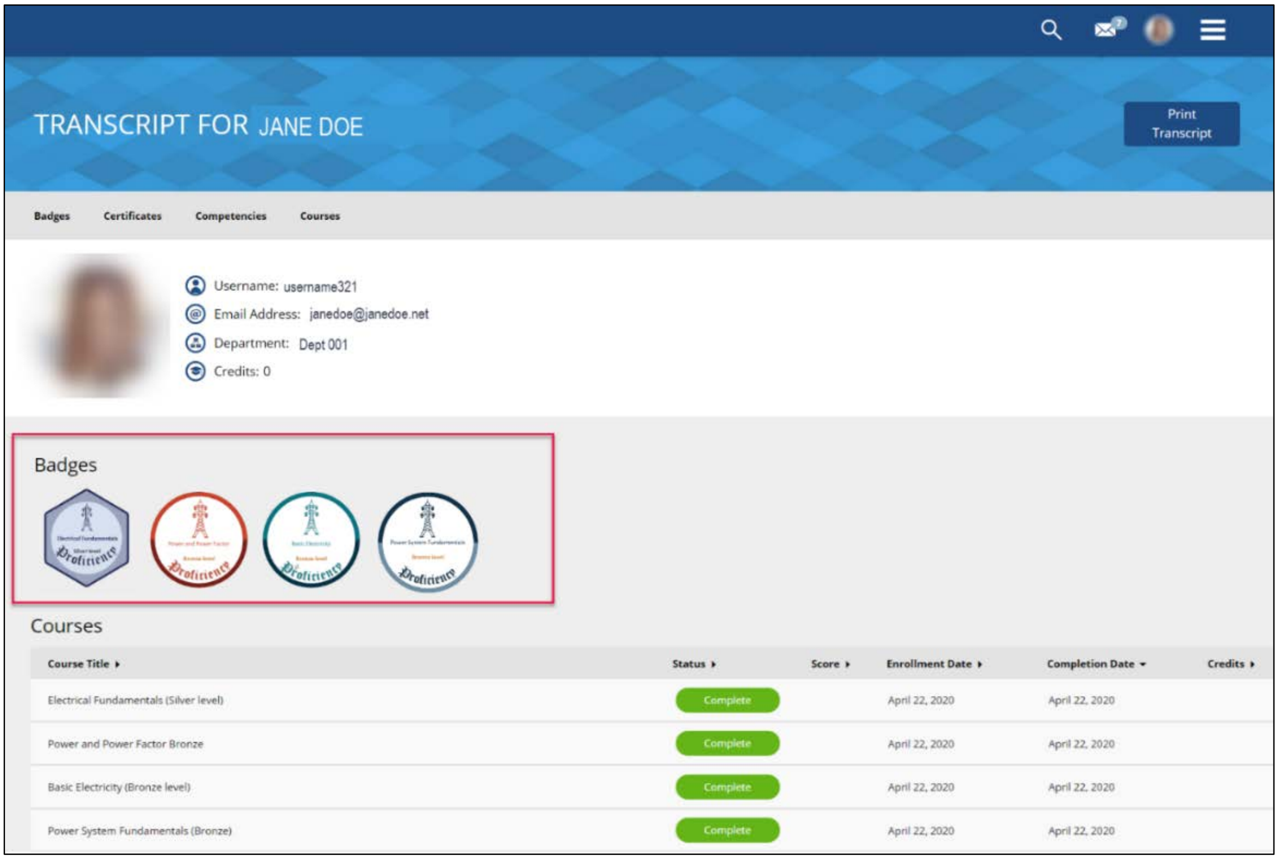
Note. To earn a bronze level badge, one has to complete the requirements of a single course successfully. To earn a silver level badge, one has to complete all three courses.

The badge images were designed using a free online digital badge creator (https://credly.com/badge-builder). The badge images were uploaded onto two separate platforms: the organization's LMS and an Open Badge Ecosystem (OBE) compliant digital credential platform. When used as a credentialing and motivational instructional strategy, a digital badge system includes information needed to determine its validity, authenticity, source, and value (Finkelstein, Knight, & Manning, 2013). This information is usually embedded in the digital badge's metadata. The metadata typically includes the recipient (the learner); the issuer (badge issuer); the badge's criteria and description (what the recipient does or demonstrates to earn the badge); the evidence (the underlying work performed to earn the badge); the date (when the badge is awarded), and the expiration (when the badge is no longer valid).

Digital badges function in learning management systems (LMS) in the same way as certificates do. They are uploaded as templates and attached to courses with a trigger to award them to any learner who successfully completes the course. Like certificates, learners can view them on their LMS transcripts and download the images if desired (Figure 2). The LMS did not have a function for embedding badge information as metadata within the badge image. This made the badge less meaningful when shared outside of the LMS.

Figure 2

Learner Transcript with Digital Badges



To provide participants with a full digital learning badge experience (Finkelstein et al., (2013), the four digital badges were also be uploaded onto an Open Badge Ecosystem (OBE) compliant digital credentialing platform. OBE platforms are used by organizations and badge earners to create, issue and share digital credentials that include Meta data. The platform also has integrations with several social media platform applications through which badge earners can share their credentials. The use of the platform is free and does not restrict users from designing and issuing badges for research purposes. The table below displays the specifics of the metadata added to each of the four digital learning badges used in this study.

Table 2

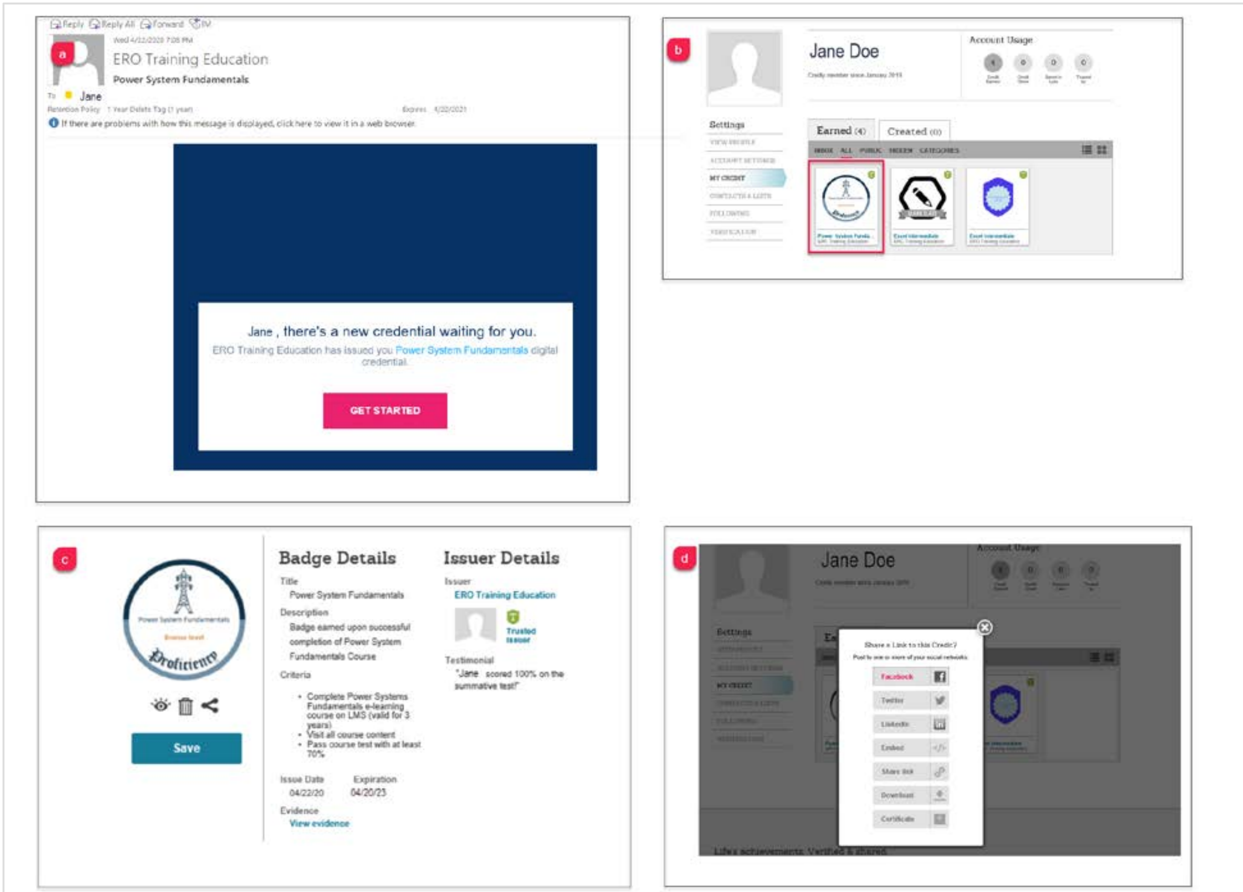
Open Badge Ecosystem (OBE) Platform Meta-data Specifics

	PSF	Basic Electricity	Power & Power Factor	Electric Fundamentals
Badge description	Badge earned upon successful completion of Power System Fundamentals course	Badge earned upon successful completion of Basic Electricity course	Badge earned upon successful completion of Power and power factor course	Badge earned upon successful completion of Power System Fundamentals course and any 2 courses out of the bulk electric system foundations library.
Badge criteria	Complete Power system fundamentals e-learning course on LMS Visit all course content Pass course test with at least 70%	Complete Basic Electricity e-learning course on LMS Visit all course content Pass course test with at least 70%	Complete Power and power factor e-learning course on LMS Visit all course content Pass course test with at least 70%	Complete Power system fundamentals course with a passing grade Complete any other 2 e-learning courses from the bulk electric systems e-learning library with a passing grade
Evidence	Learner LMS transcript must reflect successful completion of the course plus badge image	Learner LMS transcript must reflect successful completion of the course plus badge image	Learner LMS transcript must reflect successful completion of the course plus badge image	Learner LMS transcript must reflect successful completion of the course plus badge image
Validity length	Valid for 3 years	No expiration	No expiration	Valid for 3 years

The badge issuer (the researcher in this case), entered the information into the OBE platform and published it. Each published badge (Figure 3) included an image of the badge, badge details such as its description and criteria, the issuer’s details, as well as a link to download the evidence submitted as proof of having earned the badge. In the case of the present study, the evidence was a pdf printout of the learners’ transcript page showing successful completion of the course as well as the image of the badge that was earned (Figure 2). Once published, badges could be awarded to any participant who completed the requirements stipulated by the digital badge. The badge issuer pulled from course completion records on the LMS to assign digital badges to all participants who completed the requirements for earning them. Once a badge was issued, the learner received an email inviting him or her to access the digital badge on the OBE platform (Figure 3). The prompts guided the learner to activate an account on the OBE platform after which they were able to access their badge collection. Badge earners have the option to click on any badge on their badge collection to access the options available for downloading the badge or sharing it via social media (Figure 3).

Figure 3

Digital Badge Delivery and Sharing



Note. (a) Badge notification email (top left); (b) Learners' badge collection on OBE platform (top right); (c) Digital badge credential; (d) Badge sharing options

Learning Management System (LMS)

The Learning management system (LMS) used to access e-learning material in this study was a cloud-based SaaS SCORM/xAPI compliant platform. The organization used the platform to manage the entirety of the employee learning process. This included registering learners into classes or courses, administering learning materials such as e-learning, tracking student progress, maintaining training records, and analyzing learner performance. SCORM files of the three e-learning courses that were used for the study were uploaded to the LMS, where participants could access them. Two copies of each course were published: a version for the experimental group (with digital badge earning options), and a version for the control group (without digital badge earning options). The LMS administrator (researcher in this case) assigned the appropriate version of the PSF course to each participant. The LMS had a testing application, which the administrator used to upload the retention test assessment (see questions in Appendix C). The LMS also had a gamification application that included the ability to upload and distribute digital learning badges. This feature was used in the present study to issue digital badges to participants in the experimental group.

Open Badge Ecosystem Platform

An open badge ecosystem (OBE) platform was used to create, store, issue and distribute digital learning badges. OBE platforms have the architecture and API design required to connect digital badge issuer and displayer applications.

Outlook Email

Participants received automated email notifications from the LMS of the courses they had been assigned. All other instructions for the learning exercises during the experiment period were also sent from the LMS via Outlook. The OBE platform also used outlook email to invite participants to access their assigned badges.

E-learning Course Modules

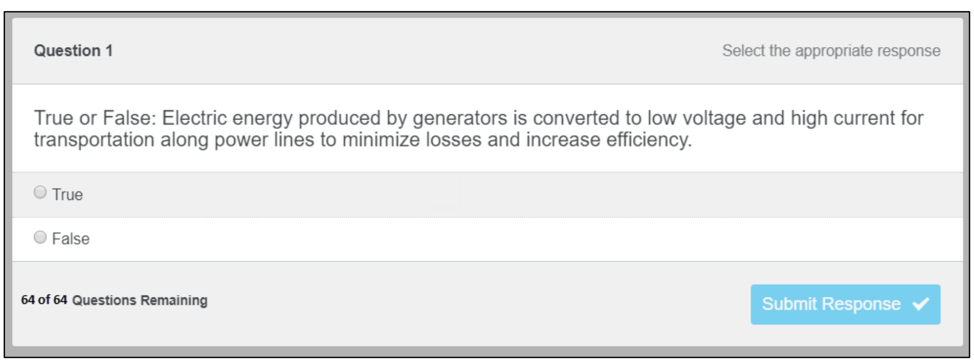
The study utilized three self-directed e-learning courses. Each course consisted of narrated content that was chunked into mini modules. Each course included a summative test (see Appendix C) that did not allow multiple attempts. Bookmarking features were applied during each courses' development to enable learners to stop at any point and be able to resume the course later, at the same point at which they stopped.

Course Delivery. Each course was prebuilt and packaged using a SCORM 1.2 compliant authoring tool that was compatible with most LMS systems. The minimum system requirements for the learner's laptop included an operating system of Windows or MAC (desktop or laptop); Internet Explorer versions eight through 11; Mozilla Firefox, Google Chrome, Safari for a browser, and an internet connection that had high-speed Internet connection, dial-up connection, or VPN.

Retention Test. Using the questions from the summative test (Appendix C), the retention test was built into the LMS using the LMS's testing application. This made it possible to assign the retention test to learners as an independent assignment separate from the course material. Learners accessed the test, which displayed one question at a time (Figure 4).

Figure 4

Sample LMS Retention Test Page



Measures

Summative Test Scores (DV1 and DV2)

Summative test scores were collected using the LMS reporting application. Once learners completed the test at the end of the required course, the course-authoring tool generated a percentage score that depicted their performance on the assessment. The course-authoring tool then exported each learner's score to the LMS, where it could be viewed in an individual learner's transcript or on a course progress report that displays all learners' scores generated for the course (see similar report in appendix A).

Cronbach's alpha was calculated for the PSF Summative test based on learner achievement scores. The results revealed a coefficient alpha reliability factor of .831 (α=.83), which rendered the test appropriate for use in this and future studies.

Course Progress (DV3)

Data on learners' course progress was collected using the LMS course progress-reporting application. The reporting feature captured and tracked the percentage of content completed by each learner in each course. A learner who enrolled in a course with 12 slides in total for instance, received a progress score of 50% if they only visited and completed the activities provided in six of the course slides. The learner who persisted to completion received a progress score of 100%, having engaged with all content and completed all activities within the course.

The researcher ran six reports – one each for the experimental and control group versions of each course. The data was combined into one Excel spreadsheet for analysis (see excerpt in Figure 15 below). Each learner's data was displayed in a single row. The learner's "average course progress" was then determined by calculating the average percentage of progress scores from the three separate courses availed to them. A learner who completed 100%, 67%, and 0% of the PSF, BE and PPF courses respectively for instance, ended up with an average progress percentage of 55.67% as shown in row one of Figure 5 below.

In order to assess the reliability of the Learning Management System's progress reporting feature, a Cronbach's alpha was calculated using learner's average progress scores. The test produced an alpha reliability score of .791 (α=.79), which is within an acceptable range of reliability.

Figure 5

Average Course Progress Data

SUBJECT ID#	GROUP	PSF-PROGRESS(%)	BE-PROGRESS(%)	PPF-PROGRESS(%)	AVE-PROGRESS(%)
1	1	100	67	0	55.67
2	2	100	100	100	100.00
3	2	100	100	0	66.67
4	2	100	76	0	58.67
5	1	100	0	8	36.00
6	1	100	0	0	33.33
7	1	100	24	0	41.33
8	2	100	12	100	70.67
9	1	100	0	38	46.00
10	1	100	12	0	37.33
11	2	100	76	0	58.67
12	2	100	100	72	90.67
13	2	100	0	0	33.33
14	2	100	100	0	66.67

Relative Autonomy Index (RAI) (DV4)

Relative autonomy index (RAI) was measured using the Learning Self-Regulation Questionnaire (SRQ-L) (Appendix D). The SRQ-L divides self-regulated behavior into two super categories: controlled regulation (external or introjected) and autonomous regulation (identified or intrinsic). A score is derived for each super-category. The two categories' scores are then combined to form a single score called the RAI by subtracting the controlled regulation score from the autonomous regulation score (Black & Deci, 2000).

The scale used for the present study was adapted from William and Deci's (1996) 14-item questionnaire for the measurement of self-regulation. William and Deci (1996) built the original questionnaire, which was based on a medical school course on medical interviewing (Appendix E). Black and Deci (2000) adapted the questionnaire for a college chemistry class. The questionnaire was designed in such a way as to be able to adapt it for any course or program of study without jeopardizing its reliability. The questionnaire for the current study was adapted for the self-directed e-learning mode of learning (Appendix D). A statement such as, "I am likely to follow my instructor's suggestions for interviewing because I would get a good grade if I do what he/she suggests" was slightly adjusted to read, "I am likely to follow my training coordinator's suggestions for engaging in this type of learning because I would have good grades on my transcript if I do what he/she suggests."

The questionnaire consisted of 14 statements. Each statement h a seven-point ratio interval scale (1 2 3 4 5 6 7) with one meaning "Not at all true," four meaning "somewhat true" and seven meaning very true. Seven of the statements (#'s 1, 3, 6, 9, 11, 13, 14) identified autonomous regulation while the other seven (#'s 2, 4, 5, 7, 8, 10, 12) related to controlled regulation.

The self-regulation survey utilized in the present study was originally assessed for reliability through studies of academic behaviors identified through a teacher survey (Ryan & Connell, 1989; Grolnick & Ryan, 1989). Ryan and Connell (1989) established external validity through comparisons with similar surveys from previous studies. Grolnick and Ryan (1989) reported the internal consistency reliability (coefficient alpha reliability factor) for the intrinsic versus extrinsic orientation to be .88 on a scale with a maximum reliability of 1.0. This confirmed a high degree of internal validity, rendering the instrument appropriate for use in research. Other studies in the past had yielded alpha reliability scores of 0.8 for the autonomous regulation subscale and 0.75 for controlled regulation subscale. The survey was administered via a cloud-based online survey development and administration tool. Participants accessed the survey via the link https://www.surveymonkey.com/r/Reasonsforlearning.

An assessment of the internal consistency of the adapted L=SRQ questionnaire used for this study yielded an alpha reliability score of 0.752 (α=.75), confirming that the scale has an acceptable degree of validity.

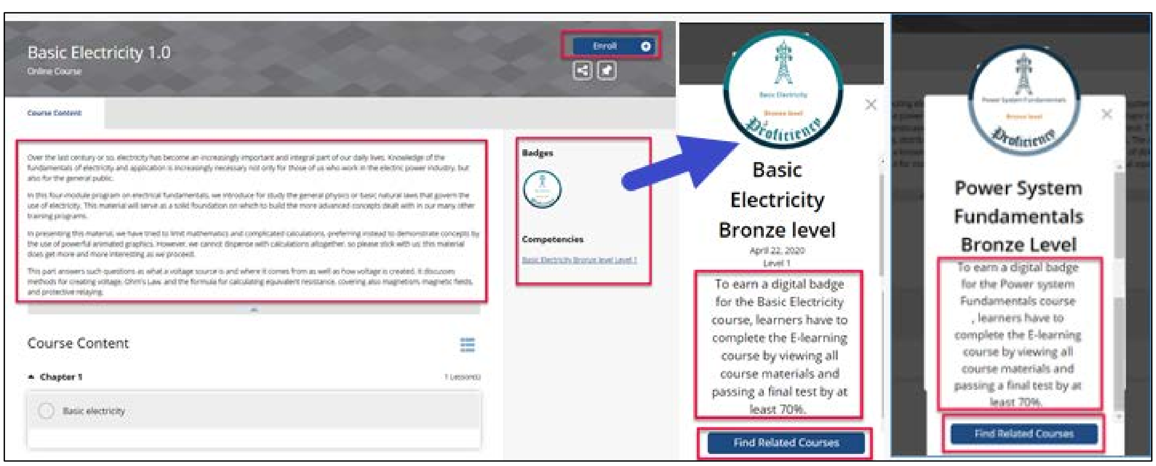
Procedures

Before the experiment, the three e-learning courses used for the study were uploaded onto the LMS platform. All other e-learning course material was hidden and made unavailable to participants for the duration of the study. All participants were enrolled in the required e-learning module. Participants then received an LMS-generated email with instructions to access and complete their required e-learning course obligations (Appendix F). The email also included a statement requesting participants to refrain from discussing, among themselves, any course details or any aspects of the learning exercise during the course of the experimental period. The same statement appeared as a pop-up announcement on all the participants' landing pages when they first access the required e-learning module. During the first week of the experiment, participants received a daily email reminder to complete the required e-learning module. These automated reminders were programmed to be sent only to participants who were yet to complete the course. The two additional volitional (elective) courses were accessible on learners' landing pages every time they logged onto the learning management system. Upon enrollment, participants had five days to complete the course, along with its summative assessment, after which it was deactivated and made unavailable for the rest of the 3-week experimental window. At the end of the first week, the researcher issued digital badges for the required e-learning module on the open badge platform. The data from the summative test was downloaded from the LMS as an Excel file.

Participants in the experimental group were then able to click the link below the badge icon on each course description page to prompt a popup showing the badge in detail as well as the criteria for earning it (Figure 6). Upon completion of each course, participants received an email confirmation with information on how to access their transcripts on the learning management system (LMS) in order to view their digital badges.

Figure 6

Digital Badge Details on Course Description Page



At the end of the three-week investigation period, the researcher administered the retention test (see questions in Appendix C) to all participants through the LMS. Participants received a notification of the assignment in their email. Upon completion of the retention test, participants received an email with directions and links to access and complete the Learning Self-regulation Questionnaire [SRQ-L] (Appendix E). Participants had three days to submit their questionnaire surveys. Learners received daily email reminders to complete and submit the survey during this period. These automated reminders only went out to participants whose submissions were pending.

At the end of the third week of the experiment, the researcher issued digital badges for the two volitional courses as well as the silver badge representing the completion of all three courses. The data from the retention test was downloaded from the LMS as an Excel file. Data on participants' course progress was also be downloaded from the LMS in preparation for analysis. At the end of the fourth week, survey data was generated from the survey administration software.

Data Analysis

All the data collected from the LMS was exported to Excel spreadsheets. Data from the SRQ-L was also be entered into an Excel spreadsheet. The data collected on participants' demographic information including age group, gender and years of experience was added to each data set within Excel. All Identifying information such as names were replaced by Excel-generated identification codes. The data was cleaned by adding fields and labels and removing any duplicate and incomplete entries before exporting it to SPSS™ statistical software for analysis. Boxplots were used in SPSS™ to identify any outliers or extreme values in the data. Since the data set was expected to be larger than 60, the distribution of all scales was inspected visually for normality (Laerd, 2015). The visual inspections revealed moderate to high levels of non-normality in all the scales. For this reason, a series of nonparametric tests (Mann-Whitney U and Kruskal-Wallis ANOVAs) were applied in all cases.

Each learners' grade on the summative test was generated by the LMS on a percentage scale. The sum of percentage grades was used to produce an average achievement score for each group, with 100% being the highest. A Mann-Whitney U test was used to analyze the difference in scores between the experimental (badged) and control (non-badged) groups. Similarly, scores from the learning retention test were used to calculate an average retention score for each group, with 100% being the highest. Once again, each learners' grade was generated by the LMS on a percentage scale. The sum of percentage retention scores was used to produce an average retention score for each group, with 100% being the highest. A Mann-Whitney U test was used to analyze the difference in scores between the two groups.

The effect of digital badges on persistence as measured by average course progress (ACP) was calculated using LMS-generated average course progress on a percentage scale. The sum of each learner's progress in all three courses was used to calculate an average progress score for each learner. The sum of average progress scores was used to produce an average progress score for each group, with 100% being the highest achievable. A Mann-Whitney U test was used to analyze the difference in scores between the experimental (badged) and control (non-badged) groups.

To calculate the relative autonomy index (RAI), each participants' SRQ-L questionnaire responses was used to calculate two subscale scores: an autonomous regulation score and a controlled regulation score. Each participant's relative autonomy index (RAI) was calculated by converting each score to a *z* score and subtracting the controlled subscale score from the autonomous subscale score. The average RAI *z* scores of the experimental group were compared to that of the control group to check for any significant differences that would indicate possible badge effect. Another Mann-Whitney U test was used to analyze these differences between the experimental (badged) and control (non-badged) groups. This test was also appropriate for this experiment because the dependent variable (self-regulation) was measured using ordinal data. An overview of the data analysis approaches are outlined in Table 3 below.

Additional analysis was carried out to compare the study's four dependent variables on the basis of a few demographic measures of interest included in the study, including gender, age category, and years of professional work experience. A series of Mann-Whitney U tests were conducted in order to compare the data on the four dependent variables on the basis of gender. To compare the data on the same dependent variables on the basis of age and years of professional work experience, a couple of sets of Kruskal-Wallis ANOVAs were conducted.

Table 3

Data Table: Quantitative Analysis

Research Questions	Dependent Variables	Data Source	Data Analysis
What effect, if any, does the application of digital badges have on adult E-learners **learning achievement** as evidenced by average posttest scores?	IV = Digital badge use DV = Learning achievement	51-item multiple choice/true-false posttest	Mann-Whitney U test
What effect, if any does the application of digital badges have on E-learners' **learning retention** as evidenced by their retention test scores?	IV = Digital badge use DV = Learning retention	51-item multiple choice/true-false posttest	Mann-Whitney U test
What effect, does the application of digital badges have on adult E-learners'	IV = Digital badge use DV = Persistence	Course progress reports from the learning management system	Mann-Whitney U test

persistence as evidenced by their average course progress?			
What effect, if any, does the application of digital badges have on adult E-learners' **self-regulation** as evidenced by their average relative autonomy index (RAI)?	IV = Digital badge use DV = self-regulation	Self-regulation questionnaire (SRQ-L): 14-item Likert rating scale on reasons for engaging in e-learning	Mann-Whitney U test

Chapter III

RESULTS

This chapter presents the results of the analyses conducted for this study. A series of nonparametric tests (Mann-Whitney U and Kruskal-Wallis ANOVAs) were carried out to investigate the effect of digital badge use on the dependent variables of learning achievement, learning retention, persistence to completion and learner self-regulation among adult learners in a corporate self-directed e-learning environment.

The results presented here are organized according to the study's research hypotheses. Each section begins with a presentation of descriptive statistics, which include mean, standard deviation, skewness, kurtosis and range. This is followed by a report on the outcomes of the statistical tests conducted on the section's variable of interest. Finally, the last section presents the results of additional analyses conducted to compare the study's four dependent variables on the basis of a few demographic measures of interest included in the study.

Learning Achievement

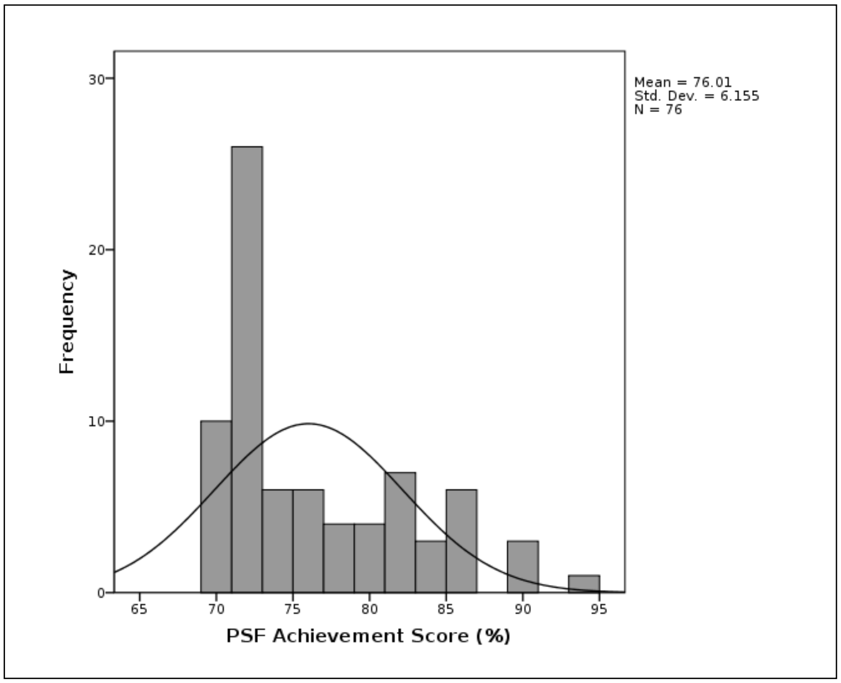
Hypothesis 1: Learners in the experimental condition will achieve higher scores on the summative posttest than those in the control group.

IV = Opportunity to earn digital learning badges; DV = PSF Achievement Score

The dependent variable, 'PSF Achievement score' was based on learners' grade percentages on the summative test taken to complete the required Power System Fundamentals (PSF) course. The level of normality present with respect to this variable is displayed below (Figure 7), suggesting a high degree of positive skewness. A preliminary screening of the data revealed no extreme outliers.

Figure 7

Histogram of PSF Achievement Score



Participants' PSF Achievement Scores ranged from 70 to 94 percent (*M* = 76.0, *SD* = 6.15). PSF Achievement Score was non-normally distributed, with skewness of 1.00 and kurtosis of 0.03. In comparison with the mean value and range, the standard deviation was found to be moderate, indicating that the variability in the data was moderate. The measures of skewness and kurtosis were not found to be extreme on the basis of these metrics, but the figure above indicates moderate non-normality. For this reason, a non-parametric model was applied in this case. In order to compare scores between the experimental (badged) and control (no badge) groups on the PSF Achievement Score variable, a Mann-Whitney U test was conducted. The test indicated that scores were higher for participants in the experimental condition (*Mdn* = 77.0) than for those in the control condition (*Mdn* = 71.5), *U* = 1075, *p* <.001. As a result, the null hypothesis was rejected in this case.

Learning Retention

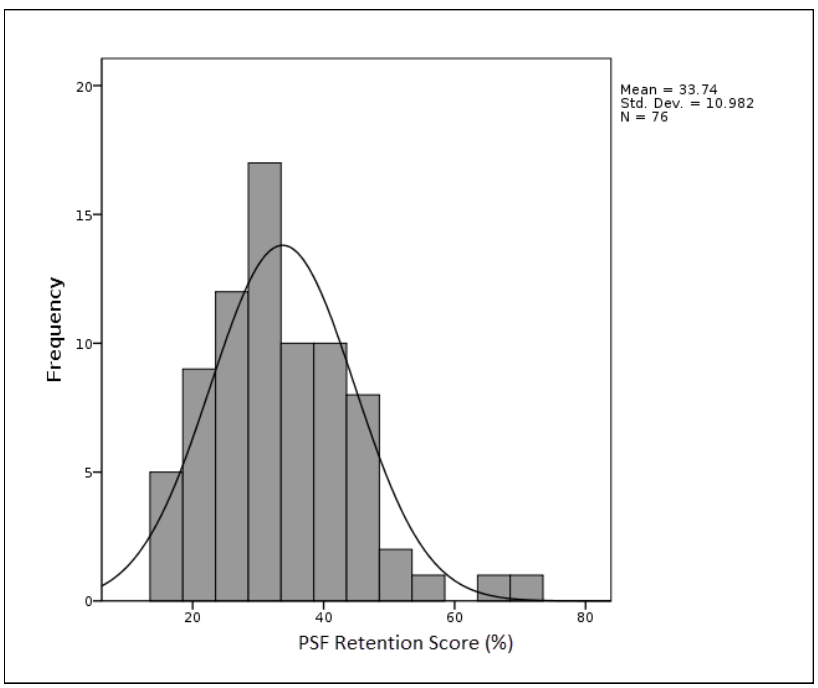
Hypothesis 2: Learners in the experimental condition will achieve higher scores on the retention test than those in the control group.

IV = Opportunity to earn digital learning badges; DV = PSF Retention Score

The dependent variable, ‘PSF Retention Score’ was derived from learners’ grade percentages on a learning retention test taken three weeks after completing the required Power System Fundamentals course. The figure below displays the level of normality with regard to the PSF Retention Score variable (Figure 8). Some positive skewness was suggested here, although this was fairly minor. A screening of the data revealed a lack of extreme outliers.

Figure 8

Histogram of PSF Retention Score



Participants' PSF Retention Scores ranged from 16 to 72 percent (*M* = 33.7, *SD* = 10.9). PSF Retention Score had a non-normal distribution, with skewness of 0.86 and kurtosis of 1.47. The standard deviation was considered moderate in comparison with the mean value and range, indicating moderate dispersion in the data. Although the measures of skewness and kurtosis were not found to be extreme on the basis of these metrics, the figure above indicated moderate to high non-normality. For this reason, the use of non-parametric statistical models was deemed appropriate. In order to compare scores between the experimental (badged) and control (no badge) groups on the PSF Retention Score variable, a Mann-Whitney U test was conducted. The test suggested that participants in the experimental condition (*Mdn* = 37.0) retained more learned content than those in the control condition (*Mdn* = 29.0), $U = 1031$, $p < .010$. The null hypothesis was also rejected in this case.

Persistence to Completion

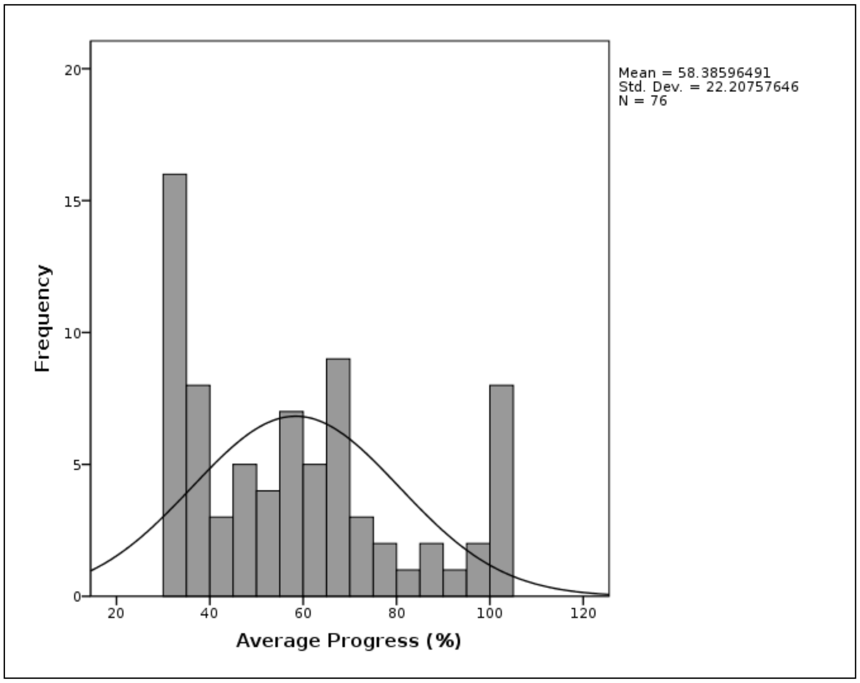
Hypothesis 3: Learners in the experimental condition will engage with a greater percentage of total course material than those in the control group.

IV = Opportunity to earn digital learning badges; DV = Average Course Progress

Persistence to completion was measured using LMS-generated reports of the percentages of total course material engaged in by each learner. The distribution of the Average Course Progress variable is displayed below, revealing a relatively flat, non-normal distribution. A preliminary check revealed no outliers in the data.

Figure 9

Histogram of Average Course Progress



Participants' Average Course Progress ranged from 33.3 to 100 percent (*M* = 58.4, *SD* = 22.2). The distribution of the Average Course Progress data was non-normal, with skewness of 0.58 and kurtosis of -0.78, both of which were not considered extreme. In comparison with the mean value and range, the standard deviation indicated moderate data variability, as displayed in Figure 8 above. As such, a non-parametric statistical model was also applied in this case. In order to compare Average Course Progress between the experimental (badged) and control (no badge) groups, a Mann-Whitney U test was conducted. Results indicated that participants in the experimental group with the opportunity to earn digital learning badges (*Mdn* = 68.7) engaged with a greater percentage of e-learning content than those in the control condition (*Mdn* = 38.0), *U* = 1353, *p* <.001. The null hypothesis in this case was also rejected.

Self-regulation: Relative Autonomy Index (RAI)

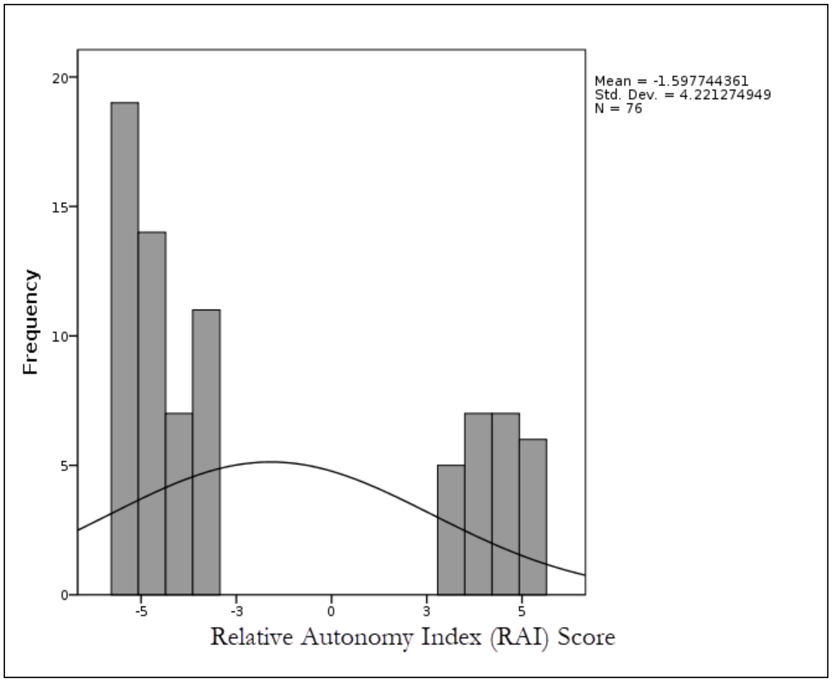
Hypothesis 4: Learners in the experimental condition will display higher levels of autonomous regulation than those the control group.

IV = Opportunity to earn digital learning badges; DV = Relative Autonomy Index

Relative Autonomy Index (RAI) was measured using the Learning Self-Regulation Questionnaire (SRQ-L), a self-reporting Likert scale type instrument that measures the extent to which an individual experiences coercive or internalized pressure to perform specific behaviors (William & Deci, 1996). The distribution of RAI Scores below displays a bimodal and non-normal layout (Figure 10). A preliminary screening of the data revealed a lack of extreme outliers.

Figure 10

Histogram of Relative Autonomy Index (RAI)



Participants' Relative Autonomy Index (RAI) Scores ranged from -5.43 to 5.57 (*M* = -1.60, *SD* = 4.22). The distribution of the RAI data was non-normal, with skewness of 0.70 and kurtosis of –1.40. In comparison with the mean value and range, the standard deviation was found to be moderate, indicating moderate data variability or dispersion. The measures of skewness and kurtosis were not found to be extreme, although the figure above indicates moderate non-normality. As such, a non-parametric statistical model was applied. In order to compare the experimental (badged) and control (no badge) groups on the effect of digital badge use on self-regulation as evidenced by RAI scores, a Mann-Whitney U test was conducted. Results suggested that participants in the experimental condition (*Mdn* = 3.64) reported higher levels of autonomous regulation than those in the control group (*Mdn* = -5.00), $U = 1309$, $p < .001$. The null hypothesis was also rejected in this case.

Additional Analyses

Additional analyses were conducted on the demographic and related measures of interest included in this study. Table 4 below presents the sample sizes and percentages of response associated with these categorical measures, which included respondent gender, age category, and years of professional work experience.

Table 4

Descriptive Statistics on Demographic and Related Variables

Measure/Category	*N*	Percent
	Gender	
Female	26	34.21%
Male	50	65.79%
	Age Category	
21-34	18	23.68%

Table 4 Continued

Measure/Category	*N*	Percent
	Age Category	
21-34	18	23.68%
35-45	22	28.95%
46-54	18	23.68%
55-64	18	23.68%
	Years of Professional Work Experience	
1-3	6	7.89%
4-9	9	11.84%
10-15	14	18.42%
16-24	29	38.16%
25+	18	23.68%

Gender

In order to compare the data on the four dependent variables on the basis of gender, a series of Mann-Whitney U tests were conducted. Results indicated that male participants' scores on the PSF Achievement test were higher (*Mdn* = 74.5) than those of their female counterparts (*Mdn* = 72.0), *U* = 906, *p* <.010. There was no difference however, between female and male participants' PSF Retention Scores (Female *Mdn* = 29.0) (Male *Mdn* = 34.0), *U* = 758, *p* = .234 or their Average Course Progress (Female *Mdn* = 52.8) (Male *Mdn* = 58.7), *U* = 713, *p* = .488. Similarly, no significant difference was detected between male and female participants with regard to the RAI Score (Female *Mdn* = -3.64) (Male *Mdn* = -4.00), *U* = 562, *p* = .331.

Age Category

Differences in data collected on the four dependent variables on the basis of age category were also compared. A Kruskal-Wallis test revealed no age category related difference with regard to PSF Achievement score, $H(3) = .651$, $p = .885$, or PSF Retention Score, $H(3) = 2.78$, $p = .427$. However, significant age related differences were detected in the case of Average Course Progress, $H(3) = 9.15$, $p < .05$, and RAI Score, $H(3) = 17.5$, $p < .010$. Pairwise comparisons conducted in relation to these two significant ANOVAs revealed no significant pairwise comparisons with regard to Average Course Progress. Pairwise comparisons of RAI Score data revealed that participants in the 21-34 age category were more autonomously regulated (*Mdn* = 3.43) than those in the 46-54 category (*Mdn* = -4.93), Test Statistic = 28.8 (*SE* = 7.34), Standardized Test Statistic = 3.92, $p < .010$. This younger age category (*Mdn* = 3.43) was also found to be more autonomously regulated when compared to the 55-64 age category (*Mdn* = -4.79), Test Statistic = 23.5 (*SE* = 7.34), Standardized Test Statistic = 3.19, $p < .010$.

Years of Professional Work Experience

Another set of Kruskal-Wallis ANOVAs was conducted to compare data on the four dependent variables with regard to participants' years of professional work experience. Results revealed no correlation between participants' years of professional work experience and their PSF Achievement Scores, $H(4) = .292$, $p = .990$, PSF Retention Scores, $H(4) = 8.35$, $p = .080$, or Average Progress, $H(4) = 3.95$, $p = .412$. However, significance differences were found with respect to RAI Scores, $H(4) = 15.1$, $p < .010$. Pairwise comparisons were conducted in relation to this significant analysis. Participants with 1-3 years of professional work experience (*Mdn* = 4.71) revealed higher levels of autonomous regulation than those with 25+ years of experience (*Mdn* = -4.79): Test Statistic = -33.0 (*SE* = 10.4), Standardized Test Statistic = -3.18, $p < .050$.

Those with less than 3 years of experience also reported higher levels of autonomous regulation than participants with 16-24 years of work experience ($Mdn = -4.43$): Test Statistic = 32.8 ($SE = 9.88$), Standardized Test Statistic = 3.32, $p < .010$.

Summary

The results of these analyses found significant median differences in all four dependent variables on the basis of group. This suggests a consequential relationship between the use of digital badges and the variables examined. Additional analyses found significant median differences between male and female participants' learning achievement. Significant differences in Average Progress and RAI Score were also detected among respondents with regard to age category. Analyses based on years of professional work experience revealed significant differences in RAI scores. These results indicate support for all four hypotheses included in this study. The following chapter will discuss these results in relation to previous literature and theory, as well as limitations of the present study and possibilities for future research.

Chapter IV

DISCUSSION

The purpose of this study was to investigate the effect of digital badge use on learning effectiveness, persistence, and self-regulation in a corporate self-directed e-learning environment. Study participants were required to complete an e-learning course in order to meet their employer's compliance requirements. They were also given access to two related but optional e-learning modules. Half the participants had the opportunity to earn digital learning badges for each course completed as well as an additional badge that designated the completion of all three courses in the series. The remaining participants, who comprised the control condition, did not have the opportunity to earn digital badges. All participants took an achievement assessment at the end of the required course and then had three weeks during which they had access to the optional e-learning content. At the end of the three weeks, an LMS-generated report of the total percentage of content completed by each learner was downloaded. Participants then took a retention test to see how much of the content they had learned was still in memory. To assess the levels of autonomous regulation at the end of the three-week duration, each participant completed the SRQ-L assessment (Ryan & Connell, 1989). The results of the study revealed significant differences between the two groups in which the opportunity to earn digital learning badges had a positive effect on all four measures examined including learning achievement, learning retention, persistence to completion and self-regulation. In this chapter, the results from the data presented in Chapter 3 are interpreted and discussed. Implications for practice and recommendations for further research are presented.

Learning Effectiveness (Achievement and Retention)

In this study, learning effectiveness was measured against two variables. The learning achievement variable was measured to test the first hypothesis, which proposed that learners in the experimental condition would achieve higher scores on the summative posttest than those in the control group. The learning retention variable was measured to test the second hypothesis, which submitted that learners in the experimental condition would achieve higher scores on the retention test than those in the control group. The learning achievement measure was based on learners' performance on a summative assessment while the retention measure was based on their performance on a retention test that consisted of the same questions as the summative test taken three weeks prior (Elliot & Harckiewicz, 1994). The results suggested a consequential relationship between the opportunity to earn digital badges and learner performance on both the summative and retention tests. The experimental group achieved higher scores on both tests, which suggested that they not only acquired more knowledge from the e-learning course, but they also retained more learned knowledge when tested three weeks later.

These results support the findings of previous similar studies (such as Sheldon, 2012), in which the use of gamification elements was found to significantly improve learner achievement as evidenced by student course letter grades. As in the case of the current inquiry, these studies examined the effect of digital badges and other gamification elements on engagement with tasks that were standardized and easily measurable (Bareket-Bojmel et al., 2014). When applied to tasks that were cognitively complex, the effect of these motivational elements became less clear, due to the fact that the tasks were already inherently motivating (Weibel, et al., 2010). Given this conclusion, it is fair to surmise that the use of digital badges in corporate self-directed e-learning has a positive influence on learning as evidenced by knowledge assessments. These assessments typically consist of multiple-choice tests that are administered at the end of an e-learning module. These types of measures are mostly simple and easily quantifiable. It would be interesting to investigate whether the use of digital badges would have the same effect on e-learning courses that may require the submission of cognitively complex evidence where learners demonstrate the application of concepts or formulas learned to real world scenarios.

With average achievement and retention scores of 73.61% and 29.60% respectively, the control group retained about 40% of what they learned. Similarly, the experimental group's average achievement and retention scores of 78.42% and 37.90% meant that they retained 48% of what they learned. Although the experimental group's higher scores indicated a positive badge effect, one must acknowledge that the amount of learned content retained was still very low (below 50%) for both groups. This poor retention rate can hardly be considered successful in a workplace setting where employees are expected to apply what they learn to their work-related roles and responsibilities. The low retention percentages however, are in keeping with previous research in which adults undertaking application-based learning tasks were found to have higher retention rates than those whose learning tasks were more abstract (Jin et al., 2019). The experimental group's higher retention scores could mean that the use of digital badges made the learning activity less abstract, thus increasing learners' cognitive involvement and engagement.

The results of the present study suggest that extrinsic rewards such as digital badges can positively influence the level of learner motivation (Urdan & Schoenfelder, 2006). The research community currently rests on the uneasy consensus that depending on how they are interpreted, external rewards can either undermine or enhance learning outcomes associated with intrinsic motivation such as improved performance (Zhou et al, 2011; Eisenberger et al., 1999). Rewards that are interpreted by the recipient as controlling tend to undermine these outcomes while those that are interpreted as informational can promote engagement. Given the positive influence that digital badges had on their performance, participants in this study appear to have interpreted the presence of extrinsic rewards as a constructive feedback mechanism rather than a controlling agent. It can be hypothesized that the meta-data embedded in a digital badge system functions as the vehicle of information and choice that promotes autonomy within a learner. It would be interesting however, to expand on the meta analyses of Cameron & Pierce (1994) and identify the specific factors of learning psychology or design that make digital badges an autonomy enhancing agent as opposed to other digitized motivational elements such as leaderboards or point systems.

The results of this study appear to strongly suggest that digital badges have a positive influence on learning outcomes related to intrinsic motivation in self-directed e-learning. However, it is prudent to consider the brevity of the present study. The results may or may not hold true in a longer-duration study that mimics the continued application of digital badges in the SDEL environment. In previous studies, extrinsic rewards were known to undermine the quality of performance by shifting one's focus from the core of the task to the reward itself. This shift in energy resulted in a surface level task engagement in which learners performed only the minimum task requirements needed to receive their desired rewards (Kuvaas et al., 2017; Hakulinen et al., 2015). This means that the better quality of learning displayed by the experimental group in this study may be a true measure of the influence of digital badges on learning effectiveness, or an expression of the learners' positive experience with the concept of "serious play" in learning. Only a study designed over a longer duration would offer conclusive insight.

Having said this, it is important to note that the experimental group performed better than their counterparts in the control group on the retention test as well. Given that no digital badges were earned in the retention test, this could only mean that participants in the experimental group effectively learned more and retained more knowledge of content after a period of disuse. Regardless of the reason their achievement scores were better than those in the control group, the fact that the retention scores were higher shows that digital badges played a role in effecting better learning.

The effect of digital badge use on learning effectiveness in the present study can also be explained through the lens of the organismic integration theory. This theory explains how an activity that is performed under external pressure can become so internalized that the underlying reasons for performing the activity change over time (Deci & Ryan, 2000). The control group's performance can be taken to reflect the learning activity's level of integration on the motivation continuum (Table 1) before the use of digital badges. Like most courses taken to fulfill a compliance requirement, it is likely that the learners underlying reasons for engagement are more control-oriented before the use of digital badges. The experimental group's performance on the other hand, can be taken to be a reflection of a shift in the activity's level of integration on the motivation continuum (Table 1) as a result of the use of digital badges. Therefore, whereas the participants may have only taken the course in order to fulfill an extrinsic end such as avoiding the negative consequences of not being in compliance, they may now engage in it because they recognize some usefulness or find it more meaningful. Their cognitive effort may reflect the fact that their approach to the course is less control-oriented and more autonomous in nature.

Additional analyses were conducted on participants learning achievement and retention with regard to the demographic variables of interest in the study. These analyses revealed no differences in achievement and retention on the basis of age category or years of professional experience. It was revealed however, that male participants scored higher on the summative test than their female counterparts. This is interesting, as it suggests that the females in the study were more control-oriented and less autonomous than their male counterparts. One would even suggest that the females appear to have exerted less effort on the learning task than the males. Interestingly enough, no differences were detected between men and women on the retention measure. This would mean that although men scored higher than women did in the initial test, they retained the same amount of knowledge in the end. The results of the achievement test may also be skewed by the fact that the females were only 34.21% (26) of the study sample compared to males who constituted 65.79% (50). This small sample of women (26) is hardly large enough to make conclusions about learning autonomy in female adult learners as compared to males. More research is needed to determine the causality orientations of women vs. men with regard to self-directed e-learning.

Persistence to Completion

Persistence in this study was measured to test the third hypothesis, which put forward that learners in the experimental condition would engage with a greater percentage of total course material than those in the control group. This Average Course Progress measure was based on the total percentage of total course content that each learner engaged with over the course of the three-week experimental period. The results indicated that participants in the experimental group with the opportunity to earn digital learning badges engaged with a greater percentage of e-learning content than those in control condition. These results are in keeping with previous studies in which digital learning badges were found to promote interest-based learning by incentivising learners to engage in self-directed learning processes (Wardrip et al., 2014).

The opportunity to earn digital badges appears to have motivated learners to enroll for the volitional courses and to persist in engagement with them to various degrees of completion. This is in keeping with the purpose and use of gamification in learning contexts which is meant to arouse learner interest and make the content more interesting so that it motivates a learner to engage with the material longer than they might have otherwise done (Deterding et al., 2011; Sarangi & Shah, 2015).

The cognitive evaluation theory can provide some insight on why participants in the experimental group ended up with higher percentages of engagement. As discussed before, one of this theory's stipulations is that rewards can undermine or promote intrinsic motivation, depending on how they are interpreted by recipients. (Zhou et al., 2011; Eisenberger et al., 1999). Rewards can be interpreted either as informational agents or as controlling factors that are contingent upon an individual's behavior. In this study, one could argue that the opportunity to earn digital badges had strong "informing" aspects as it was effective in incentivizing learners. One "informing" aspect could be in the design of the digital learning badge system. Participants had the opportunity to earn a "bronze" level badge that designated a beginner's level of mastery in each course. They also had the opportunity to earn a "silver" level badge, which designated an intermediate level of mastery in the domain and could be earned by completing all three courses in the course series. The badges in this case, not only served as rewards, but also served to mark the level of mastery that the learner had achieved the domain. This credentialing aspect in itself is an incentivizing factor that would likely encourage some learners to engage with the volitional courses to be able to appraise themselves as being on the "intermediate" rather than the "beginner's" skill level in the specified domain.

The use of digital badges to exercise choice in this way has been found to motivate learners to complete their learning pathways (Wardrip et al., 2014; Abramovich & Wardrip, 2016). In this study, participants had the choice to earn up to three independent “bronze” level badges, as well as a silver level badge, if they wanted to complete the course series. Given that the experimental group engaged with more content than the control group, one could surmise that the digital badges provided them with the license to choose the skill level they wanted to be associated with.

The difference in the percentage of average course progress between the experimental and control groups can also be explained through the lens of the organismic integration theory. According to this theory, an individual’s motivational orientation for an activity can progress along a continuum, moving from an externally regulated state on one end to a state of value integration that is indistinguishable from inherent intrinsic motivation (Ryan & Deci, 2000). The participants who engaged with the optional content were driven by extrinsic forces on the “wantivation” end of the motivation continuum (Table 1). Behavior at this level is characterized by a sense of volition, pleasure, energy, deeper learning, performing well, gratification, and persistence (Visser, 2017). The control group on the other hand, engaged with the optional continent on a limited level, revealing that they were likely operating from the “mustivation” end of the continuum. Behavior at this end of the continuum is characterized by tension, anxiety, little engagement and persistence, dissatisfaction, feelings of guilt, shame, and low sense of self-worth (Visser, 2017). The opportunity to earn digital learning badges appears to have stimulated the integration of the value of the two optional e-learning modules, such that participants who were previously driven by controlled motivations were now feeling more autonomous and operating out of a greater sense of personal choice. This corroborates the findings of Anderson et al.'s (2014, May) study in which a digital badge system was used to incentivize persistence within a Massive Open Online Course (MOOCs)

The Anderson et al. (2014, May) study however, also revealed that the effect of digital badge use appeared to reduce once participants internalized the learning behavior enough to draw motivation from within themselves. This may be a cause of concern for learning designers who may be concerned about investing in digital badge systems that may eventually run out of use. Imagining a situation in which workplace learners are self- motivated enough to initiate and persist in volitional learning out of pure integrated or inherent interest would best be described as a utopia of sorts in the learning design world. It is a situation that is theoretically possible but highly unlikely to occur.

A related concern raised in previous studies is that digital badges may temporarily increase motivation before it dissipates once the rewards are received or withdrawn (Filsecker & Hickey, 2014). In this sense, it is possible that workplace learners in the current study may engage with the self-directed e-learning (SDEL) content, only as long as the digital badges are awarded. Engagement may become dependent upon the presence of digital badges, such that learners who were previously able to engage with the content without digital badges will now be unable or uninterested in enrolling in badge-less e-learning. This extreme scenario may be mitigated by researching other factors that drive engagement in learning among adult workplace learners.

The additional tests on average course progress in relation to the demographic variables of interest explored in this study found no differences in average course progress with regard to gender or years of professional experience. There were significant differences in the percentage of content completed by learners in different age categories, although further analysis revealed no significant pairwise comparisons. The significance detected suggested a correlation between age and the variable of persistence to completion. The lack of pairwise comparisons made it difficult to pinpoint or hypothesize what factors could underlie the differences. Since persistence is a characteristic of autonomous engagement, the results might suggest that some age categories were less autonomous than others were. More research is needed to determine age-related differences in persistence to learning in the SDEL environment.

Self-Regulation

In this study, self-regulation was measured to test the final hypothesis, which proposed that learners in the experimental condition would display higher levels of autonomous regulation than those in the control group. The self-regulation measure was based on the Relative Autonomy Index (RAI), a score derived from the SRQ-L instrument (Ryan & Connell, 1989), which combines the major reasons people act on a specific activity into a score. Learners with a high relative autonomy index (RAI) in a specific domain are more likely to initiate and persist in learning activities than those with low RAI in the same domain (Black & Deci, 2000). The results indicated that participants in the experimental group with the opportunity to earn digital learning badges were more autonomously regulated when compared to those in the control condition.

There are several possible explanations as to why the experimental group reported higher RAI scores and appeared more autonomous than the control group. The digital badges seem to have made learners more autonomous in their orientation. Before the introduction of digital badges, it is possible that learners engaged in self-directed e-learning out of compulsion. This is supported by the fact that more learners in the control group engaged only with the required e-learning module and even then only achieved the minimum passing score. Learners who engage in activities that are driven by their interests or meet their values tend to perform better than those who engage out of compulsion. It is possible that the digital badges integrated the value of ‘challenge’, or ‘interest in play’, which increased their level of autonomous regulation in e-learning. The opportunity to earn badges increased the usefulness of the volitional courses, making learners in the experimental group more likely to engage with them.

As discussed before, this integration of values has been associated with lower dropout rates, higher cognitive engagement and effort, higher quality behavior and better learning outcomes (Reeve, 2002; Niemiec & Ryan, 2009). The opportunity to earn digital badges in this study resulted in greater persistence to completion, evidenced by the fact that the experimental group engaged with more content. This group also displayed higher cognitive engagement and effort, which resulted in better learning outcomes. It is reasonable to claim that the values associated with volitional self-directed e-learning were more integrated into learners within the experimental group than they were in participants in the control condition. Previous studies reveal that this level of integration is related to better performance and higher rates of course completion because the associated behaviors have been endorsed by the self (Ryan & Deci, 2000).

The results of the self-regulation experiment also make it possible to confirm the proposition that an extrinsic reward such as a digital badge can be used to move the needle on a person’s motivation for a specific activity along the motivation continuum (Parker, Jimmieson, & Amiot, 2010). The higher levels of autonomous regulation reported by participants in the experimental group suggested that digital badges increased the internalization of behaviors associated with volitional learning. These behaviors became self-determined and sustainable.

Additional tests on self-regulation in relation to the demographic variables of interest found no differences in levels of autonomous regulation with regard to gender. Differences were detected however, in the levels of autonomous regulation among different age categories. Further analysis through pairwise comparisons revealed that participants in the 21-34 age category were more autonomously regulated than those in the 46-54 and the 55-64 age category. A possible explanation for this may be that the younger 'millennial' age group was more familiar with or comfortable participating in gamified learning environments, unlike many participants in older age categories, who may have not had as much experience with serious gaming. The difference could also be explained by the likely possibility that the younger participants may have greater need to learn and grow their careers, causing them to invest more cognitive energy in the learning event. Participants in older age categories may have less incentive to be interested in learning more as they approach retirement.

Differences in levels of autonomous regulation were also detected with regard to years of professional experience. Pairwise comparisons revealed that participants with 1-3 years of professional work experience had higher levels of autonomous regulation than those with 25+ years of experience as well as those with 16-24 years of work experience. As in the case of age category, this could be explained by the possibility that participants who are new to the company were likely more inclined to invest more cognitive effort in learning new content as they sought to establish tenure in the company. More research is needed to determine differences in the causality orientations of workplace learners in different age categories.

Implications for Practice

The aim of the current study was two-fold: to establish an empirically supported position on the effect of digital learning badges on the learning motivation of corporate self-directed e-learners, and to examine the possibility of using digital badges to remedy the low voluntary engagement rates, high learner dropout rates, and poor learning outcomes that have plagued workplace self-directed e-learning. Overall, the study offered evidence in support of using digital learning badges to improve learning effectiveness and engagement among corporate self-directed e-learners. Specifically, the study arrived at the implications for practice listed below. In applying these recommendations, practitioners are urged to exercise caution and consider their unique organizational factors or circumstances. Based on the organization's environment, some of the recommendations may be applicable while others may not.

When establishing a digital badge system, consider learners' motivations for earning digital learning badges.

In order to implement digital badges in volitional learning environments successfully, it is important to understand learners' motivations for participating in the learning activity. Digital learning badges should be linked to learning outcomes that have direct value to learners (Wardrip et al., 2014). In the present study, a digital badge was awarded for meeting the minimum requirement for a compliance obligation. Additional badges were awarded for completing related e-learning modules that extended the learners' proficiency in the subject area marked for compliance. After receiving the initial digital badge symbolizing compliance, it would be reasonable to expect learners to attach value to the pursuit of related badges that symbolize deeper levels of proficiency in the area of compliance.

When establishing a digital learning badge system in a self-directed e-learning environment, begin with a few modules on subjects valued by learners before expanding to include all other e-learning courses in the library.

In order to be deliberate about using digital badges to incentivize engagement and self-regulation, it is advisable to be selective with the first set of e-learning modules to be credentialed. The selection should include a few key courses addressing targeted subject matter. By doing this, practitioners would be setting a precedence that establishes the value of digital badges among learners. This would make it easier for learners to transfer the newly established value of digital badges to other courses in their self-directed e-learning library. As is often the case, credentialing all courses in an e-learning library with badges at the same time may actually reduce the value that learners attach to them.

Digital learning badges should be meaningful outside of the learning environment.

Practitioners should design digital learning badges that have value outside of the self-directed e-learning environment. One of the primary functions of a digital badge is to have signaling power to other people about the learner's knowledge and skills. The e-learning courses to which the present study's digital badges were applied are based on competencies that are meaningful, not only to peers within the organization, but also to the wider industry of which the organization is a part. The digital badge system in the present study was also designed to enable learners to share their badges on social media platforms, making them visible to people outside of their organization.

The effort required to earn a digital badge for a self-directed e-learning course should be appreciable. It should also match the effort required to earn badges for similar or related courses.

Digital learning badges should be awarded to learners using rigorous assessment processes that carry weight and represent real achievement and learning (Lim et al., 2019). They should truly authenticate a learner's knowledge or skill against clear and measurable criteria. In the case of the present study, participants had to pass a comprehensive summative assessment in order to earn their digital badge. This required the retrieval of knowledge from their short-term memories after interacting with the e-learning module.

Design digital badge systems for self-directed e-learning in such a way that they lay down a meaningful paths of advancement for learners.

By definition, self-directed e-learners map their own learning paths. In the context of a large e-learning library, a meaningful digital badge system would not only symbolize achievement and incentivize engagement; it would also assist learners in mapping their learning paths (Gamrat et al., 2014). The digital badges assigned to courses in such a system should be able to stand on their own as well as within a larger badge family. In the case of the present study, learners could earn a single stand-alone bronze level digital badge after completing one of the courses. The digital badge system's instructions ensured that learners understood that they could earn an advanced level (silver) badge by earning two more bronze level badges. This no doubt influenced learners' decisions to pursue the additional badges as was reflected by the fact that the experimental (badged) group engaged with a greater percentage of content than the control (no badge) group.

Badges should be designed to communicate more than just completion.

This study affirms what previous research has revealed, that not all rewards are created equal. Some rewards have strong "informing" aspects in some contexts, and strong controlling aspects in others (Osterloh & Frey, 2000). It is important therefore, for learning practitioners in workplace settings to identify the types of rewards that can positively influence learning autonomy and persistence among employees. The results of this study suggest that well-designed digital badges possess strong informing aspects in the context of corporate self-directed e-learning. Designing digital badges without meta-data as is often the case with many learning management systems robs them of their full functionality. Digital badges should not just function as simple markers of course completion. Their meta-data should include information that solidifies their ability to enhance rather than undermine learners' intrinsic motivation.

When identifying an LMS system to host the self-directed e-learning program, select one that can be integrated with an open badge system.

A number of learning management systems have recently added digital badge functionality to their platforms. As mentioned before, most of these badge systems function much like certificates in that they hold no meta-data and just serve to mark learning completion. There is usually no way to share these badges outside of the LMS. It would be ideal to identify an LMS that can integrate with an open badge system. This would make it possible to design real learning badges, with meta-data, in the open badge platform before importing them into the LMS. Without the ability to share, digital badges become meaningless. Integrating an LMS with an open badge platform would make it possible to share badges earned within the LMS automatically on forums such as social media platforms.

When establishing a digital badge system, consider possible variations in learners' motivations for earning badges with regard to their demographic differences.

The additional analysis conducted on the demographic variables of interest in this study also contributed valuable insights for consideration when implementing a digital badge system in a corporate self-directed e-learning environment. The results of this study revealed varying differences in all measures on the basis of gender, age, and years of professional experience. Although the experiment did not compare the effect of digital badge use on the different demographic groups, it suggests that practitioners should always conduct an analysis of their audience when designing gamified e-learning. This type of demographic analysis will help designers better understand and customize the self-directed e-learning needs of their learners.

Limitations and Future Research Recommendations

The present study examined the effect of digital badges using tasks that were considered standardized and easily measurable. Badges were awarded on the basis of passing a multiple-choice assessment. As such, the results herein cannot be generalized to include situations in which digital badges are used for tasks that are cognitively complex. Past research in K-16 environments has revealed that the effect of digital badges became less clear in these circumstances due to the fact that the tasks were already inherently motivating (Weibel et al., 2010). Future research should investigate whether the use of digital badges would have the same effect on workplace e-learning courses that involve more complex forms of assessment.

The study sample was drawn from a pre-determined group of potential participants. The subjects were all employees at an organization that comprised a large number of employees with highly specialized skills. Although participants served in varied capacities in the organization, there was no absolute certainty that the sample adequately represented the population of adult workplace self-directed e-learners. Future inquiries using the same study design should experiment with subjects from an organization that can produce a more generalizable sample of participants.

Another limitation of the study was the fact that its design did not take into account any previous digital badge experience that participants may have possessed. Employees who had previously interacted with digital badges through gaming for instance, may not have responded positively to a digital badge system that was not as sophisticated as the ones they typically used to. Some may have engaged with digital badges to the point where their interest had waned.

Either way, the problem and questions of the current study were still valid and applicable to these subjects. The current study lays the foundation upon which researchers may make future inquiries on the effects of digital badges on seasoned badge earners.

Although additional analysis was carried out on the study outcomes based on participants' years of professional experience, no controls were put in place for prior knowledge. Participants may have been familiar with the content to varying degrees. However, this possibility was mitigated by the fact that none of the participants had engaged with the specific version of the course and assessment used for the study. Future studies could control for prior knowledge by adding pre-tests to establish each learner's base knowledge. This would make it possible to compare the actual amount of information learned by participants in a group with the opportunity to earn digital badges against a control group.

Along the same lines, the study did not control for factors such as course design that may have affected knowledge retention. It is well known for instance, that application based learning experiences result in better learning outcomes, including increased knowledge retention. Since all participants engaged with the same course content, course design as a confounding variable was mitigated. Any group differences detected were likely not a factor of course design. Past studies on digital badge use in K-16 environments determined that digital badges were not as effective when applied to learning tasks that were complex and therefore inherently motivating. There is a lack of similar inquiry involving adult self-directed e-learners. Future research among adult e-learners should compare the impact of digital badges on learners' engagement in courses with different levels of task complexity.

The online environment in which the study was conducted also created a limitation. There was no way of controlling participant communication during the experiment. Although highly unlikely, it was possible that participants who completed the PSF course ahead of others could share test information over emails or phone. This would of course, skew the summative posttest results. To mitigate this threat to the validity of the experiment, participants were asked via email to refrain from discussing, among themselves, any course details or any aspects of the learning exercise during the course of the experimental period (Appendix F). The same request appeared as a pop-up announcement on all the participants' landing pages when they first accesses the required e-learning module. Future iterations of this study design should attempt to control for participant interaction. One way of effecting this could be to use research subjects who are unaware of each other's participation in the study.

The SRQ-L Likert rating questionnaire also added a limitation to the study. As mentioned before, there was no way of knowing how authentic participants' responses would be on the Likert scale. Participants' self-reports on their self-regulated behavior may not actually reflect their true feelings about what was being investigated. This possibility however, was mitigated by the fact that the SRQ-L instrument contained online questions that were clear and unambiguous. The assurance of confidentiality also increased participants' chances of submitting authentic responses. In the future, this limitation can be mitigated further by using a mixed study design that includes interviews to explore participants' judgment of their levels of autonomy.

One of the major theoretical concerns of the present study is the fact that extrinsic rewards such as digital learning badges have been known to raise learner motivation temporarily only to have it dissipate once the reward is withdrawn or the interest in it has waned. Although the present study yielded positive results on the use of digital badges to incentivize learning engagement and effect improved learning outcomes, there is no certainty that the badges would have the same impact on the same learners in the long term. Future research should expand on the present research design into a longitudinal study in order to capture an even more accurate picture of the effect of digital badge use in the corporate e-learning environment.

The current study revealed a consequential relationship between digital learning badges and learning effectiveness and engagement in the corporate e-learning environment. Although an attempt was made in the discussion chapter to provide possible explanations for the results, further inquiry exploring the psychological processes underlying the use of digital badges would be profitable. A more granular understanding is needed on how digital badges manage to influence the integration and internalization of values on the motivation continuum (Table 1). One may hypothesize for instance, that based on the basic psychological needs theory that was not addressed in the present study, digital badges trigger internalization by increasing learners' senses of autonomy, competence and relatedness in relation to a specific activity.

The results of the study indicated a positive effect of digital badge use on learning retention. The effect however, was not large enough to be considered impactful in the practical sense. Despite being higher than the control group, the experimental group's average retention score of 37.90% still leaves the organization with an outstanding issue of poor retention of learned content. Given the importance of striving for high levels of retention of content considered important for employee performance, future digital badge research should address this issue. As previously mentioned, past research revealed higher levels of retention with application-based learning activities (Garrett, 1997). These however, are the kinds of activities that stimulate intrinsic interest in learners even before external motivators such as digital badges are applied. Future research should focus on designing digital badge systems that ensure learners continually revise learned content until they demonstrate high levels of knowledge retention. Future studies using qualitative or mixed method approaches would provide valuable contributions to this line of inquiry because they would make it possible to explore the reasons underlying the poor retention rates yielded by learners. A qualitative or mixed study would provide the researcher with the avenues to identify the nuances that shed light on how digital badges may influence retention of information.

A delimiting factor in the study was the researcher’s decision to limit the number of e-learning courses availed to participants. Unlike a typical e-learning library, participants only had access to two elective courses in addition to the required course. The ideal scenario of an investigation of learners’ engagement with volitional course material would necessitate exposure to entire e-learning libraries. The decision was made to limit this exposure however, because unlimited exposure would have made it difficult to ensure that all participants experienced the treatment in the same environment. Workplace commercial e-learning libraries are typically very large. The courses there-in cover a wide range of domains and come in multiple levels of difficulty and various standards of design. These variations would have made it difficult to generalize results, as participants would likely have engaged with a wide variety of unrelated course material. Future studies should include more courses over longer durations to provide participants with the opportunity to engage with self-directed e-learning in environments that are more realistic.

Finally, the current study conducted additional analysis on its four dependent variables with regard to three demographic categories of interest including gender, age and years of professional experience. Although this yielded some interesting results, the analysis fell short of examining the differences in the categorical measures with regard to the effect of digital badge use. Future research should expand on the present study to compare the effect of digital badge use on this study’s variables with regard to the different demographic categories of corporate self-directed e-learners.

Conclusion

The results of the present study suggested a positive effect of digital badges on the learning effectiveness and engagement of corporate self-directed e-learners. Specifically, the use of digital badges improved adult e-learners performance as evidenced by learning achievement and retention test scores. Digital badge use also increased learners’ engagement as evidenced by an increase in the percentage of total course content consumed. Based on these results, corporate e-learning designers and practitioners can implement digital badge systems to promote interest-based learning and incentivize learners to engage in self-directed e-learning. Consequently, organizations can then expect positive returns on their investments in self-directed e-learning resources.

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APPENDICES

Appendix A - Historic Power System Fundamentals Records

*Sample data shown here includes first and last pages only, with average score displayed at the end. The minimum passing grade for the course is 70. The average score of 74 indicates that learners, on average, have previously applied just the minimum level of effort required to pass the course.

LEARNER ID	COURSENAME	DATE OF HIRE	DATE COMP	SCORE(%)
7148c705-edca-41cb-b958-f191dc3e	Power Syst. Fund	9/29/2008	1/9/2017	75
3ad72d26-16e6-4a9f-b909-9dabb4c6l	Power Syst. Fund	12/1/2008	1/9/2017	71
8b5f809e-0a4f-4419-a74a-aa6e2c8ba	Power Syst. Fund	1/5/2009	1/9/2017	70
3676b856-e841-4f1d-9d97-a69e5641	Power Syst. Fund	1/20/2009	1/10/2017	70
8fbff8d1-0258-4e93-84cb-3094228f6	Power Syst. Fund	4/27/2009	1/10/2017	74
632ae9b2-fc17-4625-a86b-0517cebbl	Power Syst. Fund	1/4/2010	1/13/2017	73
3a609727-dc47-4bf6-ad99-887f02f1f	Power Syst. Fund	3/2/2010	1/12/2017	70
0a272f4f-9f9e-4f77-875a-0c06f5173	Power Syst. Fund	6/4/2010	1/12/2017	70
4d5e64a6-f7b5-41d7-b6ca-bc3501ad	Power Syst. Fund	6/7/2010	1/12/2017	70
0a58a22a-70fa-4a8a-879c-fb492af56	Power Syst. Fund	7/7/2010	1/16/2017	70
2bf63207-18f1-4060-b9a7-e1e8d2e4	Power Syst. Fund	9/17/2010	11/7/2019	84
4fd26930-1711-4711-bbcc-316489b7	Power Syst. Fund	10/4/2010	1/16/2017	70
35230084-9990-4d8d-b6c1-1016347	Power Syst. Fund	10/4/2010	1/17/2017	83
36472775-52e0-478d-be16-7b07e221	Power Syst. Fund	1/3/2011	1/23/2017	93
0f42e685-dad1-46e9-b09e-f5fa9e890	Power Syst. Fund	2/1/2011	1/23/2017	70
83c35363-11db-438f-b82c-c00bf82a	Power Syst. Fund	2/14/2011	1/30/2017	71
d5041468-4c45-47ce-a02c-a66ea02a	Power Syst. Fund	2/28/2011	1/31/2017	70
fb525568-b4e6-4424-b407-e706f0e7l	Power Syst. Fund	3/14/2011	2/3/2017	70
be89ea5a-d1f2-4d85-9f57-c1c178685	Power Syst. Fund	5/23/2011	2/14/2017	70
91cd13d3-b1e5-4c21-839b-9eb678ca	Power Syst. Fund	7/11/2011	2/22/2017	70
0681ca6f-6bf6-4d40-b13d-94de61bf	Power Syst. Fund	10/1/2011	3/1/2017	82
5ae785cf-abd9-46d8-a4cc-1fde85e64	Power Syst. Fund	1/9/2012	3/1/2017	70
060a4200-2dd1-4aa3-a823-bd91f6b4	Power Syst. Fund	1/30/2012	3/20/2017	70
4abea4f0-49b2-4db8-8ccc-08a90a3da	Power Syst. Fund	2/12/2012	3/20/2017	70
770f8847-4cb0-453e-89b5-a8703284	Power Syst. Fund	4/16/2012	3/24/2017	70
91306451-2c4b-40b2-a083-a840e48f	Power Syst. Fund	5/29/2012	3/29/2017	70
318839ae-961d-4952-9621-16bf7ba4	Power Syst. Fund	6/1/2012	4/4/2017	70
6d7c6c95-c549-4d07-b43b-f4c4a060	Power Syst. Fund	6/4/2012	4/12/2017	70
75837aa8-5a74-4119-8081-08541be6	Power Syst. Fund	8/13/2012	4/27/2017	90
921d7de8-a927-49a2-8796-42538ea7	Power Syst. Fund	8/13/2012	5/9/2017	70
8cfeae49-60c4-4b33-b8e2-0a03e0c5	Power Syst. Fund	11/27/2012	5/9/2017	70
a90e7969-4847-4dcc-8cb8-e4ee9dbc	Power Syst. Fund	12/3/2012	5/11/2017	70
ff84774c-557b-434b-ac9f-22bb816c0	Power Syst. Fund	1/2/2013	5/31/2017	70
5b809209-5cc1-4782-8be4-2e2c702b	Power Syst. Fund	1/2/2013	5/31/2017	79
e14c0832-ba52-46eb-8ccf-21d5d51c	Power Syst. Fund	3/18/2013	6/1/2017	70
5d9f3138-910e-4fcc-a26e-b872e4bb	Power Syst. Fund	8/15/2013	6/1/2017	73
8af92477-c2cb-4a65-aecd-d1b1e79d	Power Syst. Fund	9/23/2013	6/1/2017	70
315bfd03-944a-46cf-a104-5d4b9a22	Power Syst. Fund	10/7/2013	6/4/2017	70
f23ed8a8-0d1f-4009-868e-3f51e7e32	Power Syst. Fund	11/18/2013	6/6/2017	70
367cb4be-e385-46c9-9166-3e773181	Power Syst. Fund	12/9/2013	6/12/2017	70
a48942f8-5f75-46dd-960e-372eb7b6	Power Syst. Fund	3/10/2014	6/12/2017	70
2a9a5276-4149-4673-aade-80fd7cbc	Power Syst. Fund	6/9/2014	6/14/2017	91
fc795f4c-d36c-4cb7-8bc8-4e51907a2	Power Syst. Fund	6/11/2014	6/15/2017	73
fcecee1a-8d24-4443-9c44-4168f9be2	Power Syst. Fund	7/7/2014	6/19/2017	74
d8739250-40f3-48c7-bd5b-903c31b5	Power Syst. Fund	7/14/2014	6/20/2017	70
95442cc2-cdbb-43f7-b680-1e7d5677	Power Syst. Fund	8/4/2014	6/20/2017	70

347d4ab8-d158-456e-a9e1-9a5220cc!	Power Syst. Fund	2/7/2019	8/1/2019	70
597c20c7-255a-486e-ba80-2bc68fc2!	Power Syst. Fund	2/11/2019	8/5/2019	70
3284cf5d-f0c0-4fd6-ae56-b6b7219d0	Power Syst. Fund	2/11/2019	8/7/2019	90
23d18bb9-4f0c-49de-a966-e4ed7ca74	Power Syst. Fund	2/20/2019	8/7/2019	77
18ba533e-69bf-4c57-81bc-146ab6b6l	Power Syst. Fund	2/25/2019	8/7/2019	78
71d3ed40-e278-4930-8ab7-48513ecd	Power Syst. Fund	3/1/2019	11/7/2019	70
2e2fc46e-13a1-4958-b4fb-6c2d1fe34	Power Syst. Fund	3/4/2019	8/8/2019	100
b4ed617a-45b4-4b26-9348-b4f1e5ce	Power Syst. Fund	3/10/2019	8/9/2019	79
eb96f7cb-ec60-4bd5-8b0a-d541a9f86	Power Syst. Fund	3/13/2019	8/16/2019	70
ad29bfcc-9b08-4ae1-bd20-4045a70b(	Power Syst. Fund	3/25/2019	8/17/2019	72
d4741160-5d2c-4bb5-b232-a1aeac22	Power Syst. Fund	3/26/2019	11/5/2019	84
04dfefde-2a90-4bcb-9a31-f71e19eba	Power Syst. Fund	4/1/2019	8/29/2019	78
bbdc78c6-5a3b-43cd-b482-7b4d3501	Power Syst. Fund	4/1/2019	9/3/2019	71
f1a5fa42-dd8d-4b94-b6a0-6da3a5c91	Power Syst. Fund	4/1/2019	11/4/2019	73
0fa04524-c1b1-45b0-bc20-9928ba1d	Power Syst. Fund	4/7/2019	11/4/2019	72
c9163d44-1aac-4a3d-ac9d-0c39d77a!	Power Syst. Fund	4/15/2019	9/5/2019	71
a202c5ef-83d2-4f99-8a45-8760f0ef4	Power Syst. Fund	4/21/2019	9/11/2019	73
986973d3-2431-4aaf-af22-88a72b5b	Power Syst. Fund	4/22/2019	9/13/2019	90
989424b7-6cdf-44fd-af71-f119fd45a	Power Syst. Fund	5/1/2019	9/16/2019	71
5e23bc3b-843e-40b3-af9a-ee30e381e	Power Syst. Fund	5/1/2019	10/8/2019	86
b67e3a0a-e653-42d7-8662-ffd6ee877	Power Syst. Fund	5/1/2019	10/8/2019	71
729d5ff0-271d-4ef5-91ab-01978b85(	Power Syst. Fund	6/11/2019	11/3/2019	71
83f48fb6-3f4b-4df6-aa75-3f4acfaa08	Power Syst. Fund	6/15/2019	11/4/2019	70
53e8e34a-4fb0-4d30-8f13-4fc630879	Power Syst. Fund	6/15/2019	11/6/2019	70
6ad49696-7190-4ede-b4d2-ea928d4d	Power Syst. Fund	6/24/2019	11/4/2019	70
3010bd8f-c8b2-4593-bc1b-9066501e	Power Syst. Fund	6/30/2019	11/4/2019	73
c6d34c0e-65d6-4fb6-880a-75d31461	Power Syst. Fund	6/30/2019	11/4/2019	70
a525c828-4e03-40d5-9e02-7d4e1bed	Power Syst. Fund	6/30/2019	11/4/2019	70
4dd2fd0f-b3f2-4579-a4dd-80b90a62!	Power Syst. Fund	7/1/2019	11/4/2019	81
382f85f1-fd68-404a-9cf1-bfd38aea9(	Power Syst. Fund	7/1/2019	11/4/2019	70
5fdc949b-56ff-4af6-bc65-b1991b3e8	Power Syst. Fund	7/1/2019	11/7/2019	73
9c0b922b-69d6-42c1-a448-9d75999a	Power Syst. Fund	7/18/2019	11/6/2019	77
873cb53a-4c82-46eb-907d-74543651	Power Syst. Fund	7/28/2019	11/7/2019	81
2859d239-4132-41ec-b251-a5d3dc24	Power Syst. Fund	8/4/2019	11/4/2019	90
95ed0082-c192-4555-90df-796ce6df	Power Syst. Fund	8/5/2019	11/8/2019	78
d45b6a0b-b944-43c2-92c6-d7ded4aa	Power Syst. Fund	8/26/2019	11/8/2019	73
2d4db218-78b4-4d59-8677-3ba864c	Power Syst. Fund	8/28/2019	11/5/2019	72
f490196a-665d-4e9f-a176-02a4e1b6	Power Syst. Fund	9/3/2019	11/8/2019	71
81e2408b-5ee7-47bc-b35e-0fa6a4b2(	Power Syst. Fund	9/3/2019	11/9/2019	71
c73ece67-3490-417a-bf4f-294c41e9f	Power Syst. Fund	9/9/2019	11/14/2019	70
19ea206f-8a0a-452c-8ae6-b5cf306d4	Power Syst. Fund	9/19/2019	11/5/2019	70
7fab08a2-b15f-4ca6-b8ab-a68a3c6a5	Power Syst. Fund	9/23/2019	11/15/2019	72
d664cd9e-26ed-4697-bd44-f4c670df(	Power Syst. Fund	12/8/2019	11/22/2019	72
				74.33

Appendix B – Consent

OLD DOMINION UNIVERSITY

PROJECT TITLE: An analysis of the effect of extrinsic motivators on workplace self-directed E-learners' achievement, persistence, and self-regulation.

INTRODUCTION
You are being asked to be in a research study that will investigate the effect of an extrinsic motivator on learning engagement in the workplace. You are being asked to participate in this study because you are currently an employee in this organization who is due to enroll in the "Power System Fundamentals" e-learning course in order to fulfill the compliance obligation that requires you to enroll and complete the said training every 3 years.

RESEARCHERS
Responsible Principal Investigator:
Tian Luo, PhD, Assistant Professor, College of Education, STEM Education & Professional Studies

Investigators:
Emma Agola, MA, Graduate Student, Instructional Design & Technology Program, Darden College of Education, STEM Education & Professional Studies

DESCRIPTION OF RESEARCH STUDY
If you take part in the study, you will be asked to complete a survey and a questionnaire. The survey consists of questions about your experience regarding the functionality and usability of the new LMS platform. The survey will also ask you to respond to demographic items, such as age, gender, and years of experience with the company. The questionnaire consists of 12 items about the reasons why you engage in LMS based learning. The questionnaire will require you to reflect on your study habits and attitudes about your educational activities in order to rate your use of the learning resources on the LMS Platform. Each survey should take you approximately 10-15 minutes to complete.

RISKS AND BENEFITS
RISKS: There are no known risks at this time to participate in this study.

BENEFITS: Each participant in the study will be credited with **50 Employee Milestone Wheel points.**

COSTS AND PAYMENTS
There will be no costs to you for participation in this research study. The researchers are unable to give you any payment for participating in this study.

NEW INFORMATION
If the researchers find new information during this study that would reasonably change your decision about participating, they will inform you.

CONFIDENTIALITY
All information obtained about you in this study is strictly confidential unless the law requires disclosure. All data collected, including survey responses will be recorded in such a way that does not reveal your identity. All data collected will be stored electronically in a password-protected file within the organization's secure documentation system, InfoHub. You will submit your survey responses using the

organization's data encryption system (InfoHub). The results of this study may be used in reports, presentations and publications. However, only aggregate data will be used for this purpose and the researcher will not identify you. All data collected will be stored in InfoHub for a period of five years at which point it will be destroyed.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University or otherwise cause a loss of benefits to which you might otherwise be entitled.

QUESTIONS

If you have any questions about this study now or in the future, you may contact Tian Luo at the following phone number: 757-683-5369 or at tluo@odu.edu. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should contact Dr. Laura Chezan, Chair of the Darden College of Education Human Subjects Review Committee, Old Dominion University, at lchezan@odu.edu .

VOLUNTARY CONSENT/Statement of Consent

By completing this questionnaire, you are agreeing to participate in this study.

I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature_____________________________________ Date _____________________

Your Name (printed) ____

The researcher will keep this consent form for at least three years beyond the end of the study.

Appendix C –Power System Fundamentals Assessment Key

Sample Questions and Answers

Question #1	**Question**	
	True or False: Electric energy produced by generators is converted to low voltage and high current for transportation along power lines to minimize losses and increase efficiency.	
	Answers	
	True	
	False	(CORRECT)
Reference	Electrical energy produced by generators is converted to high voltage and low current for transportation along power lines to minimize losses and increase efficiency.	
Question #29	**Question**	
	What are the purposes of a power circuit breaker? (Select all that apply.)	
	Answers	
	Interrupt the flow of current under normal conditions	(CORRECT)
	Interrupt the flow of current under abnormal system conditions	(CORRECT)
	Provide a visual break in a circuit and are used for lockout/tagout	
Reference	Power circuit breakers interrupt the flow of current under normal and abnormal system conditions.	
Question #43	**Question**	
	SCADA is a powerful tool. How can it assist the Energy Control Center (ECC) operator? (Select all that apply.)	
	Answers	
	Allow monitoring of the Interconnection	(CORRECT)
	Give control to communicate data and monitor and dispatch generation	(CORRECT)
	Provide awareness of generation and outage situations	(CORRECT)
	Allow anticipation of unscheduled outages	
Reference	The SCADA system allows ECC Operators to aware of generation, interchange or tie line schedules, unit maintenance schedules and outage situations. This system gives them control to communicate data, as well as monitor and dispatch generation.	

Question #44	Question	
	What does it mean to make a system N-1 secure? (Select the best response.)	
	Answers	
	Making a system N-1 secure means it is operated with the additional capacity necessary so the equipment can adequately handle possible events or contingencies	(CORRECT)
	Making a system N-1 secure means a credible contingency has occurred and the operators must now mitigate	
	Making a system N-1 secure means the system is in a state of negation, not available due to equipment taken off-line	
Reference	Making a system N-1 secure means it is operated with the additional capacity necessary so the equipment still can adequately handle possible events or contingencies.	
Question #50	**Question**	
	Geomagnetic storms were determined to be the cause of the Quebec Blackout of 1989. Geomagnetic storms are defined as: (Select the best response.)	
	Answers	
	A solar wind shock wave that strikes the magnetic field surrounding Earth's atmosphere	(CORRECT)
	The Earth’s geomagnetic forces fluctuating due to high meteorite activity close to the Earth	
	The intensity of solar flares counteracting the Earth's gravitational force	
	An electric storm causing a disruption in a region's geomagnetic forces	
Reference	Geomagnetic storms are a solar wind shock wave that strikes the magnetic field surrounding Earth’s atmosphere.	

Appendix D -Reasons for Learning Questionnaire: Self-directed E-learning

(Adapted from William & Deci's 1996' Organic Systems: Medical Interviewing Course Questionnaire-see Appendix E below)

Part A: Demographic survey:

1. Gender: I am (check 1) Male ☐ Female ☐

2. Age: My age bracket is (check one)
   [Below 21] [21-34] [35-45] [46-54] [55-64] [65 or older]

3. Years of experience: I have _____ years of professional work experience (check one).
   [0-3] [4-9] [10-15] [16-24] [25+]

Part B: Instructions

The following questions relate to your reasons for participating in e-learning. Different people have different reasons for participating in this type of learning, and we want to know *how true* each of these reasons is for you. Use the following scale to indicate how true each reason is for you: 1 = Not at all true 4= Somewhat true 7=Very true

A. I will participate actively in this type of e-learning:

1. Because I feel like it is a good way to improve my understanding of the content.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

2. Because others might think badly of me if I didn't.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

3. Because learning this content is important for anyone working in this organization.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

4. Because I would feel bad about myself if I didn't participate in this type of learning

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

B. I am likely to follow my training coordinator's suggestions for engaging in this type of learning:

5. Because I would have good grades on my transcript if I do what he/she suggests.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

6. Because I believe my training coordinator's suggestions will help me learn effectively.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

7. Because I want others to think that I am a good employee.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

8. Because it's easier to do what I'm told than to think about it.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

9. Because it is important to me to do well at this.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

10. Because I would probably feel guilty if I didn't comply with my training coordinator's suggestions.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

C. The reason that I will continue to expand my knowledge through e-learning is

11. Because it's exciting to learn new things.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

12. Because I would feel proud if I did continue to improve my knowledge.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

13. Because it's a challenge to understand some of the concepts learned in the courses.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

14. Because it's interesting to learn about the subjects addressed.

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

Appendix E - Organic Systems: Medical Interviewing Skills

(William & Deci,1996)

The Scale

Learning Questionnaire

The following questions relate to your reasons for participating in the interviewing class. Different people have different reasons for participating in such a class, and we want to know how true each of these reasons is for you. There are three groups of items, and those in each group pertain to the sentence that begins that group. Please indicate how true each reason is for you using the following scale:

1	2	3	4	5	6	7
not at all true			somewhat true			very true

A. I will participate actively in the organ systems classes:

1. Because I feel like it's a good way to improve my skills and my understanding of patients.
2. Because others would think badly of me if I didn't.
3. Because learning to interview well is an important part of becoming a doctor.
4. Because I would feel bad about myself if I didn't study this approach.

B. I am likely to follow my instructor's suggestions for interviewing:

5. Because I would get a good grade if I do what he/she suggests.
6. Because I believe my instructor's suggestions will help me interview effectively.
7. Because I want others to think that I am a good interviewer.
8. Because it's easier to do what I'm told than to think about it.
9. Because it's important to me to do well at this.
10. Because I would probably feel guilty if I didn't comply with my instructor's suggestions.

C. The reason that I will continue to broaden my interviewing skills is:

11. Because it's exciting to try new ways to work interpersonally with my patients.
12. Because I would feel proud if I did continued to improve at interviewing.
13. Because it's a challenge to really understand what the patient is experiencing.
14. Because it's interesting to use the interview to try to identify what disease the patient has.

Appendix F – Initial Instruction Email

Greetings,

You are receiving this email because you are either a new employee or an existing employee whose Power System Fundamentals three-year validation is due for renewal. As an employee with non-engineering or power generation background, you must refresh your knowledge every 3 years by renewing your enrollment and fulfilling the course requirements with a passing grade.

We would like to invite you to participate in a survey exercise that will be performed as part of an experiment that the Training and Education team is carrying out on the quality of the course material. To participate in this experiment, we need your permission to use your feedback in our report. Please download the attached consent form, sign it electronically and return it to use as an attachment by replying to this email.

As part of our survey exercise, we will be administering a PSF content retention assessment three weeks after initial enrollment. At the beginning and end of this period, you will receive an email with links to a survey requesting information on your "reasons" for engaging in e-learning.

The required course has been assigned to your enrollments in the learning management system (LMS), which may be accessed through Infohub (click on "[redacted] learning" under "Quick") or via learning.[redacted].com. Once logged in, click the "*MyCourses*" tab and open the "[redacted] *Annual Mandatory Compliance Training*" folder to view and complete the courses in which you have been enrolled.

You have five (5) days from the date of enrollment to complete the required Power System Fundamentals e-learning course.

You will also have access to two additional (elective) courses from the "Electrical Fundamentals" domain of which the PSF course is a part. The courses will be available for a period of 3 weeks.

As stated in the consent form that you submitted at the beginning of the study, all information shared by you during this exercise will be strictly confidential. The results may be used in reports, presentations, or publications, but the researcher will not identify you.

Should you have any issues with launching the modules, please contact [redacted] The results of the study will be availed at your request upon its conclusion.

Thank you again for your assistance.

Appendix G – Permission to Research

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Sandra J Pinneke
Manager of Employee Services

April 24, 2020

Instructional Design and Technology Program
Old Dominion University
228 Norfolk, VA 23529

RE: Emma Agola

Dear Dr. Luo,

On behalf of NERC, I am writing to formally indicate our awareness of the research proposed by Ms. Emma Agola. We are aware that Ms. Agola intends to carry out a study with a group of our employees in Summer 2020 to be published in in her doctoral dissertation. I give Ms. Agola permission to continue her scholarly efforts regarding the digital badge use in e-learning project.

Sincerely,

Sandra J Pinneke

Sandra J Pinneke
Manager of Employee Services

3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

RELIABILITY | ACCOUNTABILITY

VITA

Emma Awuor Agola

STEM Education and Professional Studies Department
Darden College of Education
Old Dominion University

EDUCATION

Ph.D Candidate, Instructional Design & Technology, Old Dominion University, Norfolk, VA

Graduate Cert. in Technical Communications, South. Polytechnic University, Marietta, Ga

M.SC Education, Columbus State University, Columbus, Ga

B.A Education, University of Eastern Africa, Baraton, Kenya

PROFESSIONAL EXPERIENCE

Sr. Instructional Designer 2014 – Present
North American Reliability Corporation, Atlanta, GA

Instructional Design-Intern 2014 – 2014
AT&T University, Atlanta GA

Senior Training Manager – Design 2012 - 2014
Nebraska Public Employees Retirement System, Lincoln NE

K-12 Instructor 2004 - 2013
Atlanta Public Schools; Atlanta Ga

Instructional Content Administrator 2006 - 2009
Georgia Campaign for Adolescent Pregnancy Prevention; Atlanta, Ga

Client Support Training Assistant 2001-2004
Hewlett Packard Company, Atlanta, GA

PUBLICATIONS

Agola, E., & Stefaniak, J. (2017). An Investigation into the Effect of Job-Aid Design on Customer Troubleshooting Performance: Job Aid Design. *Performance Improvement Quarterly, 30*, 93-120.

PRESENTATIONS

Agola, E. (2017). *An Investigation into the Effect of Job-Aid Design on Customer Troubleshooting Performance: Job Aid Design*. AECT International Convention, Las Vegas, NV.