The Impact of Using a Gamified Interface on Engagement in a Warehousing Management Task: A NeuroIS Research Proposal

Mario Passalacqua, Pierre-Majorique Léger, Sylvain Sénécal, Marc Fredette, Lennart E. Nacke, Xinli Lin, Karine Grande, Nicolas Robitaille, Liza Ziemer and Tony Caprioli

Abstract Engagement, or rather lack thereof has become a major issue because of its negative impact on productivity. Recently, gamification has successfully been implemented into corporate technological interfaces to increase engagement

M. Passalacqua (✉) · P.-M. Léger · S. Sénécal · M. Fredette
Department of Management, HEC Montreal, Montreal, Canada
e-mail: mario.passalacqua@hec.ca

P.-M. Léger
e-mail: pierre-majorique.leger@hec.ca

S. Sénécal
e-mail: sylvain.senecal@hec.ca

M. Fredette
e-mail: marc.fredette@hec.ca

L. E. Nacke
University of Waterloo, Stratford School of Interaction Design and Business, Waterloo, Canada
e-mail: lennart.nacke@acm.org

X. Lin · K. Grande · N. Robitaille · L. Ziemer · T. Caprioli
JDA Software, Waukesha, USA
e-mail: xinli.lin@jda.com

K. Grande
e-mail: karine.grande@jda.com

N. Robitaille
e-mail: nicolas.robitaille@jda.com

L. Ziemer
e-mail: liza.ziemer@jda.com

T. Caprioli
e-mail: tony.caprioli@jda.com

X. Lin · K. Grande · N. Robitaille · L. Ziemer · T. Caprioli
JDA Software, Montreal, Canada

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of employees. This paper proposes a theory-driven experiment that examines the impact a gamified interface has on engagement and performance of workers in a warehouse-management task. Specifically, the experiment proposed in this paper compares how the integration of two different types of goal-setting (self-set goals or assigned goals) into a warehouse-employee interface will affect engagement and performance.

Keywords Engagement · Performance · Gamification · Information systems Electroencephalography

1 Introduction

Nearly two-thirds of warehouse employees are not engaged in their work [1]. This leads to a lack of employee productivity, a high turnover rate, more errors and less profitability; all factors greatly affect organisational efficiency [2]. In recent years, gamification of employee interfaces has been employed to combat this issue. Gamification is defined as the "use of game design elements in non-game contexts" [3]. In other words, gamification employs the engaging nature of elements used in video games to create engagement in another context. Some of the common elements used in gamified interfaces are points, levels, goal-setting, feedback, badges and leaderboards. Building upon Tondello et al.'s framework [4], the current study will focus on two of these: goal-setting and feedback. There have been very few attempts at integrating gamification into an employee user interface for technology used within a warehouse setting [4, 5]. As noted by Coffey [6], optimization within this setting has mostly focused on the task itself, rather than on the human performing it. Small [7] adeptly proposes that the lack of focus on the human provides a great opportunity to increase employee engagement through gamification.

The objective of this paper is to propose an experiment that can determine how the gamification of a warehouse employee interface affects employee engagement and performance. The experiment will also allow for the examination of the physiological mechanisms by which gamification affects performance. First, employee engagement and gamification literature will be reviewed. Hypotheses will then be presented, followed by the experimental methodology.

2 Literature Review

Literature on engagement shows that engagement is a multifaceted concept. It is comprised of behavioral, emotional and cognitive engagement. Behavioral engagement relates to participation and involvement. Emotional engagement comprises positive and negative reactions. Cognitive engagement relates to investment, thoughtfulness and willingness to put in effort towards the task [8]. Intuitively, it is easy to understand

how an engaged workforce performs better. Empirically, Harter et al. [9] performed a meta-analysis using 339 research studies and found that employee engagement is related to nine performance outcomes: profitability, productivity, turnover, absenteeism, customer loyalty, safety incidents, shrinkage, patient safety incidents and quality (defects).

Self-determination theory (SDT), a psychological theory of human motivation, has emerged as the leading theory with regards to explaining human motivation. SDT distinguishes between two types of motivation: intrinsic, which refers to motivation that comes from within, and extrinsic, which refers to motivation that results from assigned outcomes or reward. Research shows that intrinsic motivation is the main type that is used to explain underlying motivational effects of game design elements [10]. SDT states that satisfying three basic psychological needs will lead to increased intrinsic motivation: (1) competence, described as an employee feeling they can efficiently and competently deal with a challenge; (2) autonomy, defined as the sense of freedom and will when performing a task; (3) relatedness, which is the feeling of connection to others [11].

So how exactly does intrinsic motivation from a gamified interface increase employee engagement? This can be explained through the lens of the Job Demands-Resource (JD-R) model. Basically, this model proposes that the intrinsic motivation generated through the satisfaction of SDT's three basic psychological needs by the implementation game design elements results in a greater availability of motivational resources. JD-R states that when employees have enough resources to deal with job demands, engagement is greatly increased [12]. For example, integrating a self-set goal mechanism into an employee interface can increase intrinsic motivation and available resources through the autonomy of the competence aspect of SDT. In other words, allowing employees to set their own goals may give them a certain sense of autonomy.

Complementary to SDT, goal-setting theory, another well-established theory of human-motivation, provides further insight into how game elements can increase engagement, specifically, the goal-setting game element. This theory states that people are generally motivated to achieve goals. This motivation is because of self-regulation, which is the modification of thought, affect, and behavior [13–15]. In fact, decades of psychological research exist documenting how goal setting increases engagement and performance [16]. However, there is much debate on whether self-set goals or assigned goals produce greater engagement and performance. As is noted in a meta-analysis by Harkins and Lowe [17], most of the previous studies comparing self-set versus assigned goals did not take into account necessary factors for a valid comparison. Other research into this comparison has shown that goal commitment is higher when goals are self-set [18]. Because goal commitment is a strong moderator of the relationship between goals and performance [19], it can be argued that self-set goals may lead to better performance and possibly more engagement. Based on the reviewed literature, we have developed two hypotheses:

H1 The use of a gamified interface where goals are either self-set or assigned and feedback is received will lead to higher engagement and performance when compared to no gamification.
H2 The use of a gamified interface where goal-setting is self-set will lead to higher engagement and performance when compared to assigned goal.

3 Methods

3.1 Experimental Design

This study uses a within-subject design. Twenty subjects aged between 18 and 25 will participate in this study. They will be taken from our institution's participant pool. The current experiment was approved by our institution's research ethics board.

Building upon recommendations by Liu et al. [20] our experiment was designed bearing two types of outcomes in mind: experiential and instrumental. The following experiment will examine the impact of using a gamified interface on an experiential outcome (engagement) and an instrumental outcome (task performance) during a warehousing management task. In this case, a warehouse management task refers to picking specific items from various shelves and placing them into a bin. The implemented elements are goal setting (self-set vs. assigned) and feedback. Goal-setting and feedback have been integrated together because research has consistently shown that the motivational effects of goal-setting are most effective when the participant knows how he/she is progressing towards that goal, via some sort of feedback [17].

Three experiment conditions were developed to answer the research questions.

Condition 1: In this condition, participants will go through the picking task (see Sect. 3.2 for details about the task) without any set goal, without any feedback. This serves as a control condition.
Condition 2: In this condition, participants will be able to set their own goals at the beginning of the condition (e.g. The average time to complete the following task is five minutes. Today, I want to beat the average by 45 s). When participants are done, they will receive on-screen feedback about their performance (e.g. "Good job, you have reached your goal").
Condition 3: In this condition, participants will be assigned a goal (average completion time). All 20 participants will be assigned the same goal. They will also receive on-screen feedback about their performance.

We have chosen to always present condition 1 first based on what has been found in the literature. It is clear within the literature that having a task with a goal followed by a task without a goal will lead to lower engagement and performance in the latter task [21]. The order of the conditions 2 and 3 will be counterbalanced to reduce a possible ordering effect.

Fig. 1 Panasonic FZ-N1

3.2 Experimental Setup and Stimuli

A simulated warehouse was set up at the institution's research facilities, the room is 11 × 17 feet and has five metal bookshelves lined up on a wall. Also, there are four cameras set up around the room, so the participant can be seen at all times. The bookshelves were divided into three columns and four rows. Each compartment having its own unique identifier (e.g. A01001). The picking device used is the Panasonic FZ-N1, a fully rugged device with the Android operating system (version 6.0.1) (see Fig. 1). This device is about the same size as an average smartphone. This device will be strapped to the participant's arm.

3.3 Experimental Tasks

Participants will have to complete 12 picking tasks in each condition. A single picking task consists of taking a certain quantity of the same item from a compartment (e.g. pick five blue pens from A03002). Not all picks are equal in complexity (e.g. two erasers vs. five small white paper clips in small box with about 100 paper clips in various colours). Pick complexity therefore had to be operationalized to assure equal complexity in all conditions. An order picking complexity matrix was created based on research by Frazelle [22] and Errasti [23]. Simply put, pick complexity was determined by the quantity of the picked item, and its number of characteristics that add complexity (e.g. size, colour, brand, type). Because each of the 12 picks had a score, we are able to make sure pick complexity is constant across all conditions.

3.4 Measurements

As mentioned above this study will look at engagement and performance as outcome variables. Physiological measures were used to be able to capture the task engagement without interfering in the task itself, therefore maximizing the ecological validity. All physiological data will be synchronized to allow for the best possible quantification

of engagement elements, as is recommended by Leger et al. [24] and Charland et al. [25]. In this case, two of three facets of engagement can be measured physiologically. Emotional engagement can be inferred by measuring emotional valence (positive or negative), as well as emotional arousal (calm/aroused). Electrodermal activity, which is the variance in electrical conductivity in response to sweat secretions, has been shown to be a valid measure of arousal. Electrocardiography, which measures the heart electrical activity is another valid measure of arousal [26]. As for emotional valence, it can be with electroencephalography (EEG) [4]. Cognitive engagement is measured using electroencephalography (EEG), which is the measurement of neuron synchronization in the brain. To properly measure cognitive engagement, Pope et al. [27] created a validated engagement index which measures the power spectral density of three bands (beta/ (alpha + theta)) [28, 29]. This index is more complex than the one suggested in the NeuroIS literature (e.g. [30]). For more information about the physiological tools in this study, refer to the book "Fundamentals of NeuroIS", written by Riedl and Léger [31]. Goal commitment and the emotional facet of engagement will be measured with questionnaires. They will be answered on a tablet at the end of each condition, therefore they will not interfere with the task. As mentioned above, the emotional facet of engagement can be inferred by measuring valence and arousal. The Affective Slider [32], which composed of a valence slider and an arousal slider, is one of the most reliable ways to measure self-report valence and arousal. The Affective Slider is composed of two sliders. To measure goal-commitment, a five-item questionnaire recommended by Klein et al. [33] was used. As for picking performance, it will be based on two factors: time taken to complete the task compared to the average (calculated during pretests) and task errors (wrong item or quantity).

3.5 Procedure

Firstly, the physiological measures will be installed on the participant. Participants then fill out a demographic questionnaire. Participants will then be explained the picking tasks and they will have the opportunity to practice with a training task. Participants then complete the conditions. After each of the 3 conditions, participants will answer the Affective Slider, as well as the goal-commitment questionnaire on a tablet. A post-experiment interview will then be administered to gain further insight into device and interface usability, as well as condition preference.

4 Next Step and Conclusion

We believe that the proposed experiment addresses the need for theory-driven gamification research that allows practitioners to understand the underlying mechanisms behind the integration of game-design elements within a technological interface. Moreover, this study will contribute theoretically and practically to the current body

of knowledge. Theoretically, this study will allow for the direct comparison of self-set versus assigned goals, a topic that is still under debate. Practically, this study tests game-elements that can be implemented into a variety of interfaces in diverse contexts, making it of interest to practitioners.

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