An Analysis on the Formation and Cultivation of Environmental Protection Norms in the Context of Green Gamification

Yixun Lin

Helen S. Du

An Analysis on the Formation and Cultivation of Environmental Protection Norms in the Context of Green Gamification

Yixun Lin [1,2,*]
Helen S. Du[1,3]

*Corresponding author
[1] Master Student, School of Management, Guangdong University of Technology Guangzhou, China,
[2] 112008004@mail2.gdut.edu.cn
[3] Professor, hsdu@gdut.edu.cn

ABSTRACT

Currently, individual green behaviors have attracted great attention from many countries for environmental degradation. It is particularly critical to identify useful strategies to motivate users' green behaviors. Based on the goal framing theory, this paper considers three target motivations (hedonic goal, gain goal, and normative goal) of users' behaviors, proposes the formation and cultivation mechanics of green behaviors in the green gamification platform, and builds a model considering the process of users' engagement. By comparing users' quality situation (high, general, low), this paper concludes that a lower involvement degree is required by high-quality individuals when forming and cultivating an environmental behavior habit. The result also benefits organizations that apply gamification designs in varieties of ways to engage and steer users like employees or consumers toward targeted goals.

Keywords: Environmental behaviors, formation, cultivation, green gamification, goal framing theory.

INTRODUCTION

Recently, there have been many initiatives to promote environmental protection for the increasingly prominent environmental issue (Yang, Chen, & Zhang, 2020). Carbon footprint reduction is the holy grail of our times, and it can achieve through prudent energy consumption. However, the end-consumer is still the weakest link of energy conservation (Papaioannou, Hatzi, & Koutsopoulos, 2018). Nowadays, green e-commerce applications using gamification are emerging. For example, Alipay "Ant Forest" stimulates users' intrinsic motivations and attracts their continuous involvement through gamification. It helps cultivate users' green consumption habits unconsciously and brings environmental benefits indirectly. Using green gamification to promote green consumption is in line with the strategic needs of ecological civilization construction. It also satisfies the industry trend of green consumption market development. Therefore, it is significant to motivate users' green behaviors through gamification.

Let the light shoot into the office. There are three colleagues in one office. One guy didn't know where to put the used carton, so he threw them near the daily garbage can. The other two knew where to put it, but one was lazy to do that, and the other one did that sometimes. Last week, they began to play a green gamification game recommended by their boss. In the beginning, they found the game is funny. However, with the loss of freshness, they wanted to give up. But the coupon given by the platform brought them the free juice, they continued to play the game. Through the social interaction inside the game with other colleagues, they knew more about the news and knowledge about green behaviors. Through the game, their environmental knowledge increase, and all of them try to get used to some daily green behaviors, including the used carton reused behaviors. The boss said they might form the energy-saving at different times, but all of them can achieve the green behavior with the increasing involvement of the game. So, why the green gamification game is so magic? What is the real mechanism? The existing gamification cultivation design mechanics rarely has a gradual process from short-term research to long-term research, and there is little research containing discussion on the topic of green environmental protection behaviors.

This paper distinguishes three features of users (strong environmental attitude with weak environmental knowledge, weak environmental attitude with strong environmental knowledge, environmental attitude equals to environmental knowledge), and discusses the formation of the environmental norm, and the transformation of short-term to long-term goals, called environmental cultivation norm, which is changing with the increasing involvement degree of users in the green gamification platform, as shown in Figure 1. Based on the short-term needs of the hedonic goal and the gain goal, how does gamification affordance affect users' participation in gamification green activities? Based on long-term norm goal, how does continuous user engagement affect their green environmental behaviors? In order to answer the above questions, it is particularly critical to explore effectively designing gamification strategies to motivate users' green behaviors.
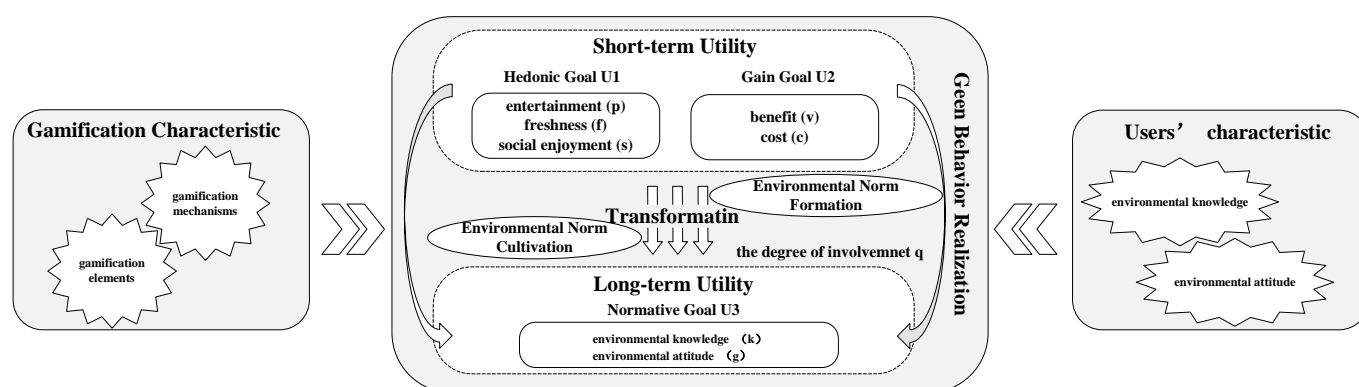
Figure 1: Research framework.

Based on the goal framing, this paper considers three target motivations of user behavior, proposes the formation and cultivation mechanics of green behaviors in the green gamification platform, and builds a model considering the process of users' engagement. First, both short-term utility (satisfy users' hedonic goal, gain goal) and long-term utility (satisfy users' normative goal), gained by users from green gamification platform, are deeply analyzed and depicted; then, according to the established utility model, we mainly concern the decision point, analyze and solve the formation point and the cultivation point; finally, example analysis is given to verify the solution. By comparing three types of users (individual quality of high, medium, and low), this paper concludes that high-quality individuals with strong environmental attitudes and weak environmental knowledge can form and cultivate a habit of green behavior, acquiring a lower involvement degree than the other two kinds of participants. And the above result will not be affected by the contribution ratio of hedonic experience and expectancy-value to short-term value. The result can be used by organizations that are applying gamification designs in a variety of ways to engage and steer employees and consumers toward targeted goals.

BACKGROUND AND MODEL PREMISE

In goal framing theory, Lindenberg and Steg (2007) point out that individual behaviors are mainly influenced by three motivation goals: hedonic goal, gain goal, and normative goal. Especially, the hedonic goal refers to the individual pursuit of short-term emotional experience (such as hedonic experience), while the gain goal refers to the individual chase of maximum benefit (such as expectancy-value) after weighing costs and benefits in the short term. However, the normative goal refers to individuals' compliance with behaviors they deem appropriate (such as environmental norms). These three goals can also correspond to emotional motivations, interests weighing motivations that are likely to affect individual green behaviors in the short term, ethical and normative motivations formed in the long term (Hsu & Chen, 2018; Sun et al., 2018). Therefore, goal framing theory provides a suitable theoretical perspective for exploring individual green behaviors and motivations.

Gamification is a design concept that incorporates gamification elements into non-game situations (Liu et al., 2017). It can build a whole game in a virtual environment. It is composed of some gamification elements, mechanics, and other gamified technical features (gamification features) (Tobon et al., 2020). To increase the gamefulness and funness of the system, gamification elements, mechanics, and other technical means could be added to the system design. In this way, users' psychological needs can be satisfied, and their participation motivations can be stimulated. (Koivisto & Hamari, 2019). Affordance refers to users' perceptions that technology provides them with the possibility to implement actions, connecting the relationship between gamification features and user psychology (Chen et al.,2019). Gamification affordance is an effective perspective to analyze the intrinsic relationship between gamification features and user psychology, representing the extent to which users perceive that they are likely to use gamification information systems to perform tasks (Suh et al.,2017). Gamification design is centered on meeting users' needs and stimulating their participation motivations. Through the reasonable combination of gamification elements and gamification mechanics, users' psychological needs can be satisfied by gamification features, thereby promoting users' participation in specific tasks (Moro et al.,2019). Furthermore, gamification elements are system components that show game information to users, while gamification mechanics are rules and methods designed for players to interact with gamification information business systems (Featherstone & Habgood, 2019; Liu et al., 2017). Through the reasonable configuration and effective design of gamification elements, mechanics, and other gamification features, different target motivations of users can be stimulated, which promotes their participation in green gamification activities and then stimulates users' green environmental protection behaviors. To design an attractive gamification information system and promote the continuous participation of users, it is necessary to deliver the affordance given by gamification features, namely gamification affordance successfully (Suh et al.,2017). The combination of gamification features of gamification information system and users' subjective feelings will empower users to produce different gamification manifestations or affect users' feeling degree (Koivisto &Hamari, 2019; Suh & Wagner,2017).

According to the above discussions about gamification and goal framework, a good design of a green gamification platform can enhance users' hedonic experience (U_1), as well as their expectancy-value (U_2), attracting users to continue engaging in green gamification activities. When users get involved in gamified green activities for a long time, their environmental protection

norms are more likely to transfer from gamified platform to real life (U_L), thus guiding users to transform from participating in gamified green activities to green behaviors. By describing the process of users' involvement in green gamification activities, we measure the short-term utility ($U_S = U_1 + U_2$) and long-term utility (U_L) of users under the influence of different gamification design strategies are of value. Through solving the balance between short-term utility and long-term utility of users, the optimal gamification design strategy to motivate users' green behaviors can be explored.

The occurrence of most phenomena in real life can be described by Poisson distribution. The changes of users' involvement degree in the process of gamification's rise in rank also show a similar distribution. That means users within a certain level range (such as the middle level) have the highest involvement degree. Users at a low level feel too easy to feel enthusiasm. Conversely, users at high levels have a sense of frustration due to the difficulty of the promotion. Both of these two situations lead to a relatively low involvement degree. Therefore, it is assumed that the user's level promotion is independent and obeys the Poisson distribution with a parameter λ. Then, we have:

$$P(X = k) = \frac{\lambda^k}{k!} e^{-\lambda}, \ (k = 0,1,2, \dots), \tag{1}$$

where $P(X = k)$ is the probability that the user will be promoted to level k during the game participation process. The users' degree of involvement q is directly affected by the promotion probability, we then have $q = \gamma P(X = k), \gamma > 0$, where γ indicates a constant coefficient. The user involvement degree is essential to both the short-term and long-term utility of users. It is also the main factor to achieve the balance and transformation of the short-term and the long-term utility of users and to stimulate green behaviors. Other gamification affordance, e.g., rewards (marks, points), visualization of achievement (rank, status), self-presentation (medals, trophies), competition (leaderboards, challenges), interaction (social bond), are also subject to Poisson distribution. Here, we focus on the short-term utility and long-term utility of strategy design based on the middle-level promotion mechanism of visualization of achievement.

ANALYZE AND DEPICT THE SHORT-TERM UTILITY AND LONG-TERM UTILITY
The Utility Combination Representation of Hedonic Experiences in Short-Term Goals
The hedonic goal is one of the main motivations affecting users' involvement in gamified green activities in the short term. According to the results from previous literature (Koivisto & Hamari, 2019; Werbach & Hunter, 2012), the user's hedonic goal in the gamification context can be divided into three types of hedonic experiences: challenge enjoyment, experimental enjoyment, and social enjoyment. Among them, challenge enjoyment refers to the playfulness that users experience when they successfully respond to challenges or solve problems in the process of involvement in gamified green activities. Experimental enjoyment refers to the freshness experienced by users during their involvement in gamification. Social enjoyment refers to the pleasure derived from users' involvement in gamification by making social bonds with others. Flow is a user's emotion about an activity or a thing. Flow theory believes that when a person is immersed in a certain activity, there is a temporary loss of self-awareness of himself or herself. He or she will think that time passes faster and will perceive challenge of the activity matches his or her skills (Berger, Schlager, Sprott, & Herrmann, 2017). In the context of gamified green e-commerce, users' experience of the sense of entertainment, freshness, and social bonds through gamified interactive activities will stimulate users' hedonic-goal motivation, promote their immersion in gamification information system and generate flow. In this way, users' willingness to participate in gamified green activities and the degree of involvement can be improved (such as extending users' immersion time, raising users' daily liveness, improving game proficiency, etc.). Therefore, the following model assumptions about the combination of hedonic experience utility in short-term goals need to be considered:

- According to the hypotheses, user involvement is q. There is a positive correlation between the sense of entertainment in the hedonic goal and the degree of user involvement. We then have $P(q) = pq + \theta_1$, where $p > 0$ is the entertainment coefficient. When the engagement scale θ_1 equals to 0, the sense of entertainment is not evaluated.
- The novelty of the hedonic goal is inverse, which can be represented as $F(q) = \frac{f}{q}$, where $f > 0$ is the freshness coefficient.
- Social enjoyment in the hedonic goal is positively correlated with user involvement. Then we have $L(q) = sq$, where $s > 0$ is the social enjoyment coefficient.

To sum up, the users' hedonic goal is a utility function (U_1) of users' involvement in gamified green activities. Therefore, in the short term, the utility function of the hedonic goal can be represented as

$$\max \ U_1(q) = P(q) + F(q) + L(q) \tag{2}$$
$$\text{s. t.} \quad q > 0$$

The Utility Combination Representation of Expectancy-Value in Short-Term Goals
The gain goal is one of the main psychological motivations affecting users' involvement in green gamification activities in the short term. Under the gain goal orientation, many individuals pay more attention to the change of their resource quantity or resource efficiency. Besides, users are very sensitive to the information of value brought by their behaviors (Lindenberg & Steg, 2007). Prospect theory points out that the expectancy-value brought by behavioral tasks will affect users' perception of resources and revenue, which is an important factor to affect individual behaviors (Chipulu, Marshall, Ojiako, & Mota, 2015). Based on prospect theory (Trautwein et al., 2012), the users' gain goal in the context of gamification include four expectancy values: attainment value, utility value, intrinsic value, and cost. Especially, attainment value refers to the value of one person's sense of

accomplishment after completing the behaviors, such as the sense of accomplishment obtained by comparing the rankings with other users. Utility value refers to the external value that an individual expected behaviors such as raffles, coupons, and consumption bonuses after online payment might bring benefits. Intrinsic value refers to the subjective value that can satisfy one's intrinsic needs, e.g., the voluntary tree-planting certificate issued by Ant Forest can satisfy one's psychological need to display one's individuality. Although these values cannot directly meet individual needs, they can be transformed internally to make it. On the contrary, cost refers to the cost generated by individual behaviors (the time and energy paid by participating in gamified green activities), which belongs to a negative value (Sun et al., 2018). It can be seen that the more value enhancement for a player in the context of green e-commerce, the more willingness to get involvement will be generated by users. The involvement degree will also increase at the same time. Therefore, the following model assumptions about the combination of expectancy-value and utility in the short-term goals are proposed:

- According to Wigfield et al. (1996) and Trautwein et al. (2012), based on expectancy-value theory, let α be the attainment value coefficient; u be the utilization value coefficient; denote i as the intrinsic value coefficient. Considering the expected income coefficient $v > 0$, the comprehensive expectancy-value coefficient is formulated as $v = \alpha + u + i$, where $\alpha, u, i > 0$.

- The attainment value, utility value, and intrinsic value contained in the expectancy-value of the gain goal are positively correlated with the user involvement degree (Trautwein et al., 2012). Therefore, let $V(q) = vq + \theta_3 = (\alpha + u + i)q + \theta_3$ be the value function. When the degree of involvement equals to 0, the expectancy value is not evaluated, so $\theta_3 = 0$.

- According to Eccles, Wigfield (2002), and Trautwein et al. (2012), the cost of individual behaviors is a negative value. It has a U-shaped relationship with user involvement. Specifically, there is a certain effort required for users to participate in the early stage and to keep learning about the game. As the degree of involvement deepens, users are likely to closely consider the opportunity cost of each of their decisions and feel performance anxiety for fear of failure after they reach a certain height. So, there is an appropriate level of engagement along with the lowest overall cost to the user. Then the function equation between cost and the degree of involvement can be represented as $C(q) = a_2 q^2 + b_2 q + c_2$, where $a_2, c_2 > 0, b_2 < 0, \frac{4a_2 c_2 - b_2^2}{4a_2} > 0$.

To sum up, the users' gain goal is the utility function (U_2) of user's involvement degree q in green gamification activities. So, the utility function of the gain goal in the short term is defined as:

$$\max U_2(q) = V(q) + C(q) \tag{3}$$
$$\text{s.t.} \quad q > 0$$

Users' short-term utility U_s includes the pursuit of the hedonic goal and the gain goal. Short-term utility U_s consists of hedonic utility U_1, and gain utility U_2. Based on flow theory, "hedonic utility" U_1 is composed of users' hedonic experience of entertainment, freshness, and social bonds. Based on the prospect theory, "gain utility" U_2 consists of expectancy-value factors: attainment value, utility value, intrinsic value, and cost. So, the short-term utility function U_s is:

$$U_s(q) = \alpha_1 U_1(q) + \alpha_2 U_2(q), \quad \alpha_1, \alpha_2 \; \epsilon[0,1] \tag{4}$$

The short-term utility function U_s derived from the above is:

$$\max U_s(q) = \alpha_1 U_1(q) + \alpha_2 U_2(q) \tag{5}$$
$$\text{s.t.} \quad q > 0$$

The Utility Portfolio Representation of a Specification in Long-Term Goal
The normative goal is the main psychological motivation that affects users' green behaviors in the long term. The normative goal refers to the constraints of cognition and attitude on individual behaviors, which must be met in the process of individual behaviors implementation (Wittenberg, Blöbaum, & Matthies, 2018). Based on the results of current literature (Kibourne & Pickett, 2008; Wittenberg et al., 2018), users' perception of the normative goal of personal behaviors will be influenced by environmental norms (Norm). Therefore, the environmental norms of environmental knowledge and environmental attitude are taken as the measurement of the normative goal. Among them, environmental knowledge indicates the user's knowledge and understanding of environmental knowledge. Environmental attitude refers to the user's subjective attitude towards environmental behavior (Steinhorst & Klöckner, 2017). The normative goal can influence the users' inner demand for green behaviors for a long time and restrain behaviors at the same time. The study found those users with higher environmental norms are more inclined to make altruistic green behaviors than the users with lower environmental norms. Thus, the former one is more likely to engage in green behaviors (Steinhorst & Klöckner, 2017). The normative goal mainly affects the green behaviors of users from the aspect of social norms. Previous literature shows that the stronger an individual environmental norm is, the more likely he or she is to engage in green behaviors that benefit the interindividual (Günther, Kacperski, & Krems, 2020; Kibourne & Pickett, 2008).

Construct the cognitive dissonance coefficient $B = \frac{k}{g} - 1 \; \epsilon \, [-1,1]$, where k>0 indicates the coefficient of environmental knowledge, g>0 represents the coefficient of environmental attitude.

- According to cognitive dissonance theory, when users are continuously involved in gamified green activities and complete a series of gamification tasks related to environmental protection, new environmental knowledge and attitude will be

generated in the game. However, when users return to reality, the new cognition and attitude of environmental protection may be inconsistent with the original cognition and attitude. To eliminate such dissonance, users will change the old cognition and attitude of environmental protection to obtain psychological balance. At this point, there are the following three cases:

(1) When environmental knowledge is consistent with environmental attitude, then we have $k = g$. That means there is no cognitive dissonance, so the cognitive dissonance coefficient is about 0, $B = 0$.

(2) When environmental knowledge is far less than environmental attitudes, $k < g$ is held, which shows that users belong to a high-quality group, their environmental attitudes are higher, now $-1 < B < 0$.

(3) When environmental knowledge is far greater than environmental attitudes, $k > g$, It shows that the environmental knowledge provided by gamification can hardly change users' environmental attitudes, now $0 < B < 1$.

● Users' original environmental knowledge and attitude will gradually be changed by continuous involvement in long-term self-adaptation in the gamification process. This helps to form the environmental protection norms that are conducive to the common interests of individuals and gradually deepen. In the long-term process, assuming that the involvement degree $q > 1$, the normative utility target in the long-term will show exponential growth as the involvement degree deepens: $U_L(q) = e^{[q-B]}$. Given that different users' environmental knowledge and attitudes show different relationships when discussing different cases of cognitive dissonance coefficient " B, "there will be the following situations:

(1) When the cognitive dissonance coefficient $B = 0$, $U_L(q) = e^q$. That means the normative utility shows normal growth.

(2) When the cognitive dissonance coefficient $B\epsilon[-1,0]$, At the same level of involvement, this user's long-term utility $U_L(q)$ increases most rapidly.

(3) When the cognitive dissonance coefficient $B\epsilon[0,1]$, At the same level of involvement, this user's long-term utility $U_L(q)$ increases relatively slow.

To sum up, the user's long-term normative goal U_L is the utility function of the user's involvement degree q in green gamification activities. In the long term, the utility function of the normative goal is defined as:

$$U_L(q) = e^{[q-B]} = e^{\left[q-\left(\frac{k}{g}-1\right)\right]} \tag{6}$$

$$\text{s.t.} \quad q > 1$$

THE ANALYSIS OF UTILITY MODEL AND OPTIMAL DECISION POINT SOLUTION

In short-term goals, the utility function of involvement degree is as follows:

$$U_s(q) = \alpha_1\left[(pq + \theta_1) + \frac{f}{q} + sq\right] + \alpha_2[vq + \theta_3 + a_2q^2 + b_2q + c_2] \tag{7}$$

$$\text{s.t.} \quad q > 0$$

In the long-term goal, the utility function of involvement degree is as follows:

$$U_L(q) = e^{[q-B]} = e^{\left[q-\left(\frac{k}{g}-1\right)\right]} \tag{8}$$

$$\text{s.t.} \quad q > 1$$

The Formation Point of Environmental Protection Norms

With the increase of users' involvement, both short-term utility and long-term utility of users rise according to their respective function rules, as shown in (7) and (8). When two utility functions grow at the same rate, that is,

$$\frac{\partial U_s}{\partial q} = \frac{\partial U_L}{\partial q} \tag{9}$$

At this point, the derivative of the short-term utility to the involvement degree is equal to the long-term utility, and the equilibrium of short-term utility and long-term utility growth is achieved. This point can be regarded as the goal attainment point of the norm. Based on the involvement degree of this point, the environmental protection attitude of users can be changed to form the environmental protection norm. After this point, the growth rate of the long-term normative utility of users is significantly higher than that of the short-term utility, and the main motivation of users' green gamification activities begins to shift from hedonic experience and expectancy-value to target norm, which generates the possibility of users' green behaviors.

To find the solution of the formation point of environmental protection norms, first of all, from the above,

$$\frac{\partial U_s}{\partial q} = \alpha_1 p - \frac{\alpha_1 f}{q^2} + \alpha_1 s + \alpha_2(v + 2a_2 + b_2)$$

$$\frac{\partial U_L}{\partial q} = e^{q-\left(\frac{k}{g}-1\right)}$$

Then,

$$\alpha_1 p - \frac{\alpha_1 f}{q^2} + \alpha_1 s + \alpha_2(v + 2a_2 + b_2) = e^{q-\left(\frac{k}{g}-1\right)}$$

Transform the above formula,

$$e^{q-\left(\frac{k}{g}-1\right)} + \frac{\alpha_1 f}{q^2} = \alpha_1 p + \alpha_1 s + \alpha_2(v + 2a_2 + b_2)$$

The left-hand side of the equation contains the unknown element q, and the right-hand side is a constant. Let $K = \alpha_1 p + \alpha_1 s + \alpha_2(v + 2a_2 + b_2)$, then the equation becomes: $e^{q-\left(\frac{k}{g}-1\right)} + \frac{\alpha_1 f}{q^2} - K = 0$. We can let $f(q) = e^{q-\left(\frac{k}{g}-1\right)} + \frac{\alpha_1 f}{q^2} - K$. Then we can find,

$$f'(q) = e^{q-\left(\frac{k}{g}-1\right)} - \frac{2\alpha_1 f}{q^3}$$

It can be seen that $f(q)$ decreases firstly and then increases, the inflection point is x, and x is the solution of $q^3 e^q = 2\alpha_1 f e^{\left(\frac{k}{g}-1\right)}$ (transform from the above formula).

And then, we know that the minimum value of $f(q)$ is $f(x)$. At this point, the following three cases need to be discussed:

1, $f(x) = 0$, think about $\frac{\partial U_S}{\partial q} = \frac{\partial U_L}{\partial q}$ there has one point that x can be held.

2, $f(x) < 0$, think about $\frac{\partial U_S}{\partial q} = \frac{\partial U_L}{\partial q}$, there are two points that one is over x, and the other belongs to the range $[0, x]$ are held.

3, $f(x) > 0$, then $\frac{\partial U_S}{\partial q} = \frac{\partial U_L}{\partial q}$ has no point, that is, $\frac{\partial U_L}{\partial q} > \frac{\partial U_S}{\partial q}$ establishes constantly. At this point, there is no formation point of environmental protection norms.

The Transition Point of Environmental Protection Norms
After the formation of the environmental protection norms, although users begin to break away from the dominance of short-term enjoyment and profit motivations, it is difficult to motivate users' green behaviors because the long-term utility of users is lower than the short-term utility. With the further deepening of user involvement, when the long-term utility growth of users is consistent with the short-term utility, namely:

$$U_S = U_L \tag{10}$$

It can be regarded as the transition point between the user's short-term goals and the user's long-term goals. After this point, long-term utility surpasses short-term utility, and users no longer need to stimulate enjoyment and gains through gamified green activities but spontaneously carry out green behaviors due to the cultivation of environmental protection norms.

By solving the above two key points, we can calculate one certain involvement degree, which can be calculated. In this involvement degree, uses happen to reach the environmental protection norms and form the green behaviors. According to the distribution law of involvement degree at this moment, the optimal gamification grade design strategy that encourages users to continue to participate and carry out green behaviors can be determined. We can find,

$$\alpha_1\left((pq + \theta_1) + \frac{f}{q} + sq\right) + \alpha_2(vq + \theta_3 + a_2 q^2 + b_2 q + c_2) = e^{q-\left(\frac{k}{g}-1\right)}$$

Transform the above formula,

$$\alpha_1 pq + \frac{\alpha_1 f}{q} + \alpha_1 sq + \alpha_2 vq + \alpha_2 a_2 q^2 + \alpha_2 b_2 q - e^{q-\left(\frac{k}{g}-1\right)} = -\alpha_1\theta_1 - \alpha_2\theta_3 - \alpha_2 c_2$$

Among them, let $P = -\alpha_1\theta_1 - \alpha_2\theta_3 - \alpha_2 c_2$ can be regarded as a constant.
Therefore, let

$$g(q) = \alpha_1 pq + \frac{\alpha_1 f}{q} + \alpha_1 sq + \alpha_2 vq + \alpha_2 a_2 q^2 + \alpha_2 b_2 q - e^{q-\left(\frac{k}{g}-1\right)},$$

we can find,

$$g'(q) = 2\alpha_2 a_2 q + \alpha_1 p + \alpha_1 s + \alpha_2 v + \alpha_2 b_2 - e^{q-\left(\frac{k}{g}-1\right)} - \frac{\alpha_1 f}{q^2}$$

$$g''(q) = 2\alpha_2 a_2 + \frac{2\alpha_1 f}{q^3} - e^{q-\left(\frac{k}{g}-1\right)}$$

Let $g''(q) > 0$, then $q < X_1$, X_1 is the solution that $g''(q) = 0$, and the solution can be obtained by binary search. Therefore, we know that $g'(q)$ is increasing at $[0, X_1]$, and decreasing at $[X_1, +\infty]$. In it, $max\ g'(q) = g'(X_1)$. There are two cases that need to be discussed,

1, $g'(X_1) < 0$, which means $g(q)$ is decreasing at $[0, +\infty]$. When $g(0) > 0$, there is a zero point in it, and the solution can be obtained by binary search.

2, $g'(X_1) > 0$, then we let $X_2 \in [0, X_1]$, and $X_3 \in [X_1, +\infty]$. The solution can be obtained by binary search through letting $g'(q) = 0$. So, we can know $g(q)$ is decreasing at $[0, X_2]$, increasing at $[X_2, X_3]$, and decreasing at $[X_3, +\infty]$. In this case, there are several situations that need to be discussed:

2.1, When $g(X_2) > 0$, there is a point that satisfies $U_s = U_L$, which locates at $[X_3, +\infty]$ and can be obtained by binary search.

2.2 When $g(X_2) = 0$, there are two points that satisfy $U_s = U_L$, the one of which is X_2, and the other located at $[X_3, +\infty]$ and can be obtained by binary search.

2.3 When $g(X_2) < 0$ and $g(X_3) > 0$, there are three points that satisfy $U_s = U_L$, which are respectively located at $[0, X_2]$, $[X_2, X_3]$, $[X_3, +\infty]$.

2.4 When $g(X_3) = 0$, there are two points that satisfy $U_s = U_L$, the one of which is X_3, and the other located at $[0, X_2]$.

2.5 When $g(X_3) < 0$ and $g(0) > 0$, there is a point that satisfies $U_s = U_L$, which locates at $[0, X_2]$.

2.6 When $g(0) = 0$, there is a point that satisfies $U_s = U_L$, which is the zero point.

2.7 When $g(0) < 0$, there is no point that satisfies the equation.

EXAMPLE ANALYSIS

When the corresponding parameters are set as shown in Table 1, the process of the formation and the cultivation of the user's environmental protection norm can be seen in Figure 2, showing that the formation of the environmental protection point is generated at $[0,1]$ and $[3,4]$. Since we definite that calculated should meet $q > 1$, which is a prerequisite for long-term utility function discussion. Therefore, the degree of involvement at $[3,4]$ is focused. With the increase of involvement, users gradually meet the environmental norm formation point. Before the environmental regulations are formed, the growth rate of the short-term utility of users is higher than that of long-term utility ($\frac{\partial U_s}{\partial q} > \frac{\partial U_L}{\partial q}$); after the formation of environmental protection norm, although the short-term utility of the early users is still higher than the long-term utility of the users ($U_s > U_L$), because the long-term utility is growing faster than the short-term utility ($\frac{\partial U_s}{\partial q} < \frac{\partial U_L}{\partial q}$), users gradually develop environmental norms. At this point, when the short-term utility function intersects the long-term utility function, the user realizes the cultivation of environmental protection standards ($U_s = U_L$). After that, the user's long-term utility rises exponentially, that is, much higher than his short-term utility ($U_s < U_L$), which is consistent with our initial hypotheses.

Table 1: Preliminary parameter settings 1.

parameter	$\alpha 1$	$\alpha 2$	p	f	s	v	K/g	q	$\theta 1$	$\theta 3$	$a2$	$b2$	$c2$
value	0.1	0.9	0.9	0.9	0.9	0.7	1	0.1	0	0	0.5	-1	1

Source: This study.
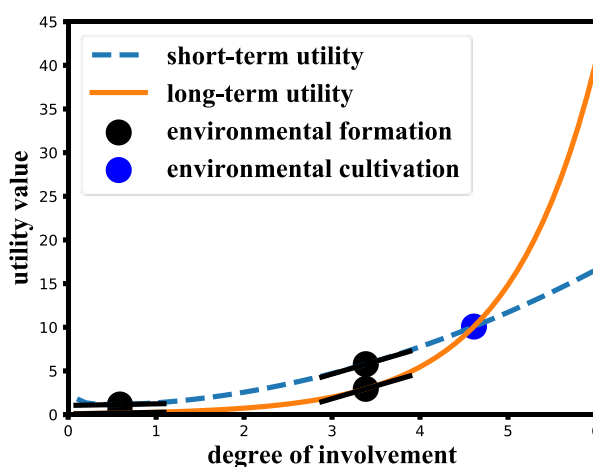
Source: This study.
Figure 2: Short-term and long-term utility diagram in the process of users' increasing involvement.

The Formation of Environmental Protection Norms

Suppose there are three types of users (B = 0, −1 < B < 0, 0 < B <1, B = $\frac{k}{g}$ − 1 ϵ [−1,1]). They correspond to environmental knowledge that is consistent with environmental attitude ($k = g$), environmental knowledge that is far less than environmental attitude ($k < g$), and environmental knowledge is far more than environmental attitude ($k > g$). The detailed discussion on the formation and development of environmental protection norms for the three types of users is as follows. The parameter settings of the three user types are shown in Table 2.

Table 2: Parameter settings for three types of users 2.

Type	High–quality individuals	General public individuals	Low-quality individuals
Definition	Environmental knowledge is far less than environmental attitude ($k < g$)	Environmental knowledge is consistent with environmental attitude ($k = g$)	Environmental knowledge is far more than environmental attitude ($k > g$)
Value	$K = 0.5g$	$K = g$	$K = 2g$

Source: This study.

Figure 3 shows the changing trend of involvement q corresponding to the formation point of environmental protection norms, as the freshness f changes when the parameters $\alpha1$ and $\alpha2$ are set. Taking Figure 3-a as an example, in the case of involvement $q > 1$, the user type is $K = 2g$. Participants who have environmental knowledge are stronger than environmental attitude when compared with users with lower environmental knowledge than environmental attitude ($K = 0.5g$), higher involvement is required to realize the formation of environmental norms. Meanwhile, for users with environmental knowledge equal to environmental attitude ($K = g$), the level of engagement required to shape environmental norms falls somewhere in between. Different $\alpha1$ and $\alpha2$ represent the proportions of hedonic experience and expectancy-value in the short-term utility function. As can be seen from the following example figure, when discussing freshness f under different values of α1 and α2, the high-quality group has a lower involvement degree than other types of users in realizing the formation of environmental protection norms. According to the figure, it can be preliminarily concluded that $\alpha1$ and $\alpha2$ do not affect the relative value of the involvement degree of three types of users in the formation of environmental protection norms.
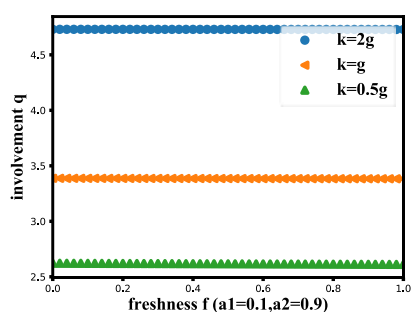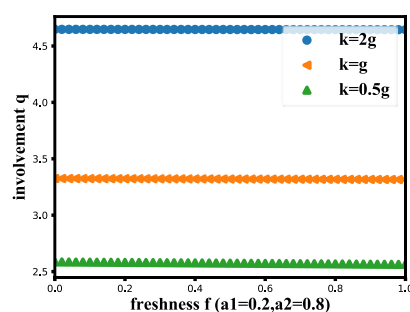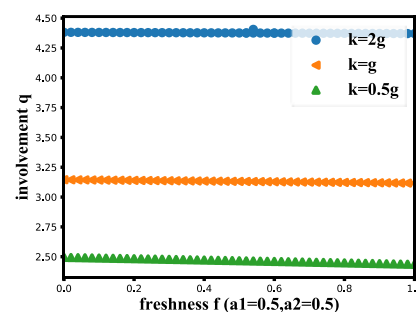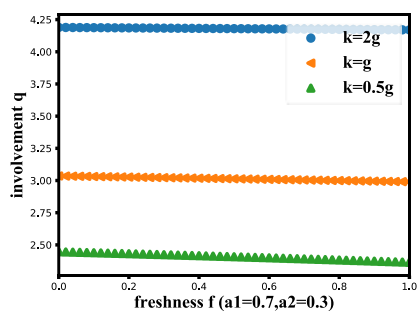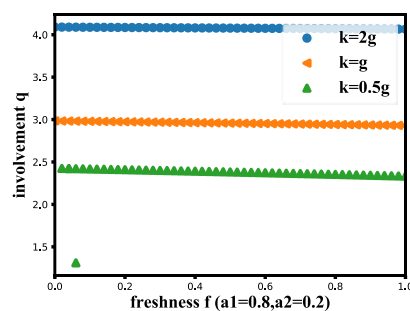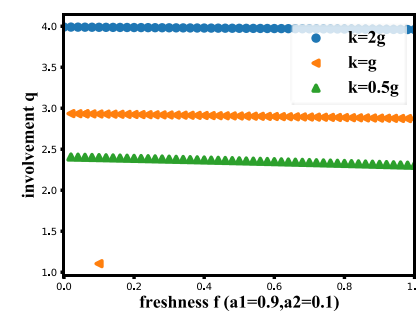

Figure 3-a

Figure 3-b

Figure 3-c

Figure 3-d

Figure 3-e

Figure 3-f

Source: This study.

Figure 3: The changing trend of goal formation points with involvement q in the changing process of freshness f.

Control other parameters. When discussing a specific parameter (such as entertainment p), further set parameters based on Table1, as shown in Table 3. By observing the results of the variation of different parameters—the variation trend of the formation points of environmental protection norms and the relative situation of three types of users, it can be seen that when the high-quality group, the general public group, and the low-quality group realize the formation of environmental protection norms, their requirements for involvement degree increase successively.

Table 3: Preliminary parameter settings 2.

	α1	α2
entertainment p	0.9	0.1
freshness f	0.1	0.9
social enjoyment s	0.5	0.5
value v	0.1	0.9
cost c	0.5	0.5

Source: This study.

Figure 4-b, and Figure 4-d respectively represent the situation when the concerned parameters are freshness f and cost c. As it can be seen from the figure, when the parameter values are shown in Table 3, the involvement degree of three types of users in forming environmental protection norms will not change significantly with the increase of freshness f or cost c. Figure 4-c and Figure 4-e represent the situation when the concerned parameters are social enjoyment coefficient s and value v respectively. It can be seen from the figure that when the parameter values are shown in Table 3, three types of users form environmental protection norms. The corresponding involvement requirements increase with the raising of social enjoyment s or value v. To sum up, when the values of relevant parameters are shown in Table 3, in the process of participating in green environmental protection games, the degree of freshness in the enjoyment experience brought by games and the fluctuation of utility cost in the expectancy-value have almost no interference on the formation point of environmental protection norms. However, the change of social enjoyment in hedonic experience or value in expectancy-value will affect the formation of three types of user environmental protection norms. That is, there is a corresponding change trend in the requirements of involvement degree. Correspondingly, Figure 4-a represents the situation when the attention parameter is entertainment p. In particular, there are two key points for users to achieve environmentally normative behaviors. Focuses on the situation with high involvement degree (as shown in the figure, $p = 1.5$), which is similar to the changing trend of social enjoyment s.
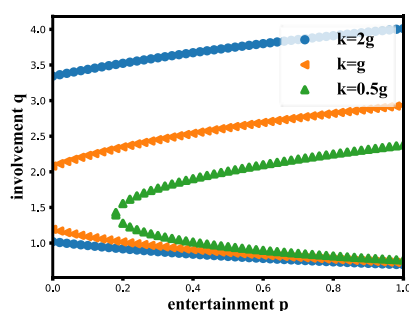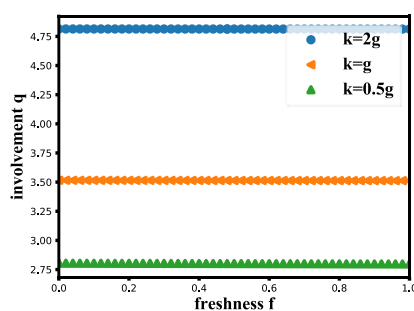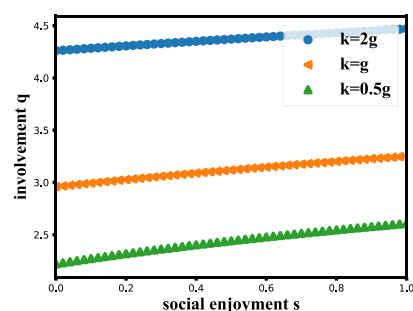

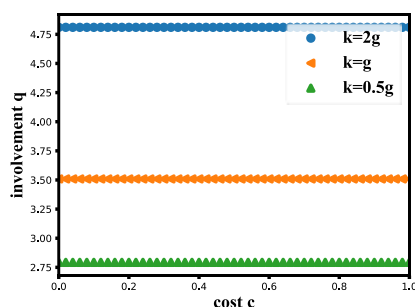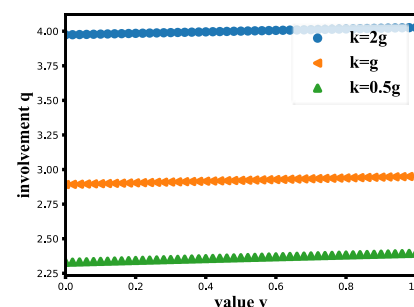Figure 4-a

Figure 4-b

Figure 4-c

Figure 4-d

Figure 4-e

Source: This study.

Figure 4: Environmental norm formation points.

To sum up, when it comes to three kinds of users, it can be seen that when the high-quality group, the general public group, and the low-quality group realize the formation of environmental protection norms, their requirements for involvement degree increase successively. Furthermore, $\alpha1$ and $\alpha2$ do not affect the relatively required involvement degree of three types of users in the formation of environmental protection norms when focusing on one parameter. When discussing a certain parameter, the change of values of $\alpha1$ and $\alpha2$ will mainly affect the change of the specific involvement degree required by the formation of environmental protection norms while this effect is less than the effect of the type of users itself.

The Cultivation of Environmental Protection Norms

In the study of environmental protection norm cultivation, when discussing a specific parameter (such as entertainment p), similarly, the parameter setting is further adjusted based on Table 1, as shown in Table 4. It is similar to the formation point of environmental protection norms. By observing the results of the changes of different parameters——the changing trend of the cultivation point of environmental protection norms and the relative situation of three types of users, it can be seen that when high-quality people, ordinary people, and low-quality people realize the cultivation point of environmental protection norms, their requirements for involvement degree also increase successively.

Table 4: Preliminary parameter settings 4.

	α1	α2
entertainment p	0.9	0.1
freshness f	0.1	0.9
social enjoyment s	0.5	0.5
value v	0.1	0.9
cost c	0.5	0.5

Source: This study.

Based on parameter setting in Table 4, by observing Figure 4-b, that is, mainly pay attention to the freshness f. At this point, the involvement degree of the three types of users in the realization of environmental protection norms will not change greatly with the increase of the freshness f. It means that in the process of participating in green environmental protection games, the increase and decrease of the freshness f in the process of the game will almost not interfere with the cultivation point of environmental protection norms, that is, there is no evident change in the requirements for the involvement degree.
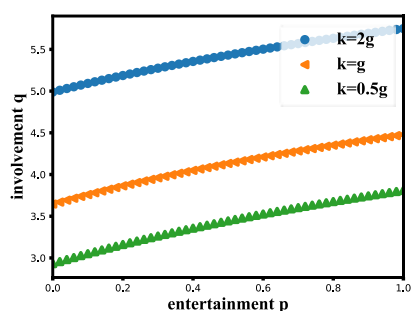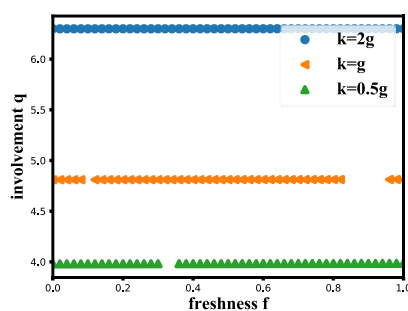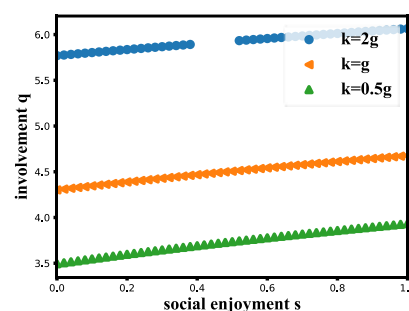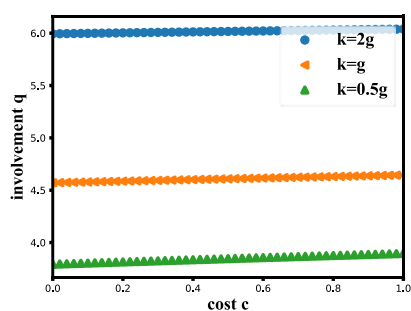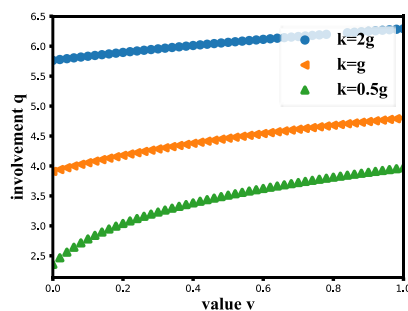

Figure 5-a

Figure 5-b

Figure 5-c

Figure 5-d

Figure 5-e

Source: This study.

Figure 5: Environmental norm cultivation points.

Figure 4-a, Figure 4-c, Figure 4-d, and Figure 4-e respectively represent the situation when the parameters are entertainment p, social enjoyment s, cost c, and value v. It can be seen from the figure that the parameters are set, as shown in Table 4. When three types of users are discussed to develop environmental protection norms, the requirements for the corresponding involvement degree will raise with the increase of each parameter when reaching the critical point of developing environmental protection norms. In addition, with the increase of cost c, social enjoyment s, and entertainment p, the involvement degree required to realize the cultivation point of environmental protection norms is gradually increased. It can be concluded that the changes of entertainment p, social enjoyment s, cost c, and value v will affect the cultivation of three types of user environmental protection norms. That is, there is a corresponding trend of changes in the requirements for the involvement degree. In particular,

Figure 4-e represents the situation where we focus on value v. When $v < 0.2$, the change of value in the process of the development of environmental protection norms has a stronger impact on the requirements of involvement.

To sum up, when it comes to three kinds of users, it can be seen that while the high-quality group, the general public group, and the low-quality group realize the cultivation of environmental protection norms, their requirements for involvement degree go up successively. Furthermore, $\alpha 1$ and $\alpha 2$ do not affect the relative involvement degree of the three types of users in the development of environmental protection norms when focusing on one parameter. When discussing a certain parameter, the change of values of $\alpha 1$ and $\alpha 2$ will mainly affect the change of the specific involvement degree required by the cultivation of environmental protection norms, while this effect is less than the effect of the types of the users itself.

In summary, the following conclusions can be drawn:
(1) When the high-quality crowd, the general public crowd, and the low-quality crowd realize the formation and cultivation of environmental protection norms, their requirements for involvement degree all increase sequential. It means the high-quality crowd in their early involvement can form and develop environmental protection norms. This result is not affected by the contribution proportion of hedonic experience and expectancy-value to the short-term utility function.
(2) Considering the influences of the changes of entertainment p, social enjoyment s, value v, freshness f, and cost c on the formation and cultivation of environmental protection norms by users in the short-term expected goals, it can be known that: The different proportions of hedonic experience and expectancy-value experienced by users in short-term goals of the game process will affect the formation of environmental protection norms, and influence the level of users involvement required by the cultivation of environmental protection norms, but this effect is weaker than that of the types of users.

CONCLUSION

Existing research of gamification cultivation mechanics rarely has a gradual process from short-term research to long-term, and there is little research containing discussion on the topic of green environmental protection behaviors. Based on the goal framing, this paper considers three target motivations of user behavior, proposes the formation and cultivation mechanics of green behaviors in the green gamification platform, and builds a model considering the process of users' engagement. According to goal framing theory, this paper focuses on the green gamification platform in order to contribute to individual green behaviors, then provides ideas for potential strategies in the ways of effectively designing gamification, especially discusses the formation and cultivation point considering the short-term utility and long-term utility at the same time. Contributions of this research are as follows.

Theoretically, this paper deduces the process of how gamification affordance effects users' involvement in green gamification activities in the short term of the hedonic goal and the gain goal. Besides, this paper answers the questions of how continuous user engagement affects their green environmental behaviors on long-term norm goals. Specially, we infer the formation and cultivation of the users' green behaviors in view of the short-term utility (satisfy users' hedonic goal, gain goal) and long-term utility (satisfy users' normative goal). Last but not least, we broaden the gamification platform design in the way of the goal framework utility.

Practically, this paper finds out that when the high-quality individual, the general public individual, and the low-quality individual realize the formation and cultivation of environmental protection norms, their requirements for involvement degree all increase sequential, which can be used by the organizations who are applying gamification designs in a variety of ways to engage and steer employees and consumers toward targeted goals. Here, we focus on green behaviors' formation and cultivation. The potential design gamification strategies can motivate users' green behaviors effectively.

Some limitations also are in this paper. First of all, this paper focuses on the short-term utility and long-term utility of strategy design based on the middle-level promotion mechanism of visualization of achievement. However, another gamification affordance such as self-presentation (medals, trophies), competition (leaderboards, challenges) is also subject to Poisson distribution, all of which can also be discussed in the future. Furthermore, based on our results, we hope that our study could be extended by exploring the mix match of different parameters and deducing the reason why it could be, comparing the results, and finding other better-optimized solutions for different situations. Besides, the uses' cultivation habits may decrease as time goes by. Other mechanisms should be discussed in the next step in the future, which help to build a long-term formation in another special situation.

ACKNOWLEDGMENT

REFERENCE

Berger, A., Schlager, T., Sprott, D. E., & Herrmann, A. (2017). Gamified interactions: whether, when, and how games facilitate self–brand connections. *Journal of the Academy of Marketing Science*, 46(4), 652-673. doi: 10.1007/s11747-017-0530-0

Chen, L., Baird, A., & Straub, D. (2019). Why do participants continue to contribute? Evaluation of usefulness voting and commenting motivational affordances within an online knowledge community. *Decision Support Systems*, 118, 21-32. doi: 10.1016/j.dss.2018.12.008

Chipulu, M., Marshall, A., Ojiako, U., & Mota, C. (2015). Reasoned ethical engagement: Ethical values of consumers as primary antecedents of instrumental actions towards multinationals. *Journal of Business Ethics*, 147(1), 221-238. doi: 10.1007/s10551-015-2994-5

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual review of psychology*, 53(1), 109-132. doi: 10.1146/annurev.psych.53.100901.135153

Featherstone, M., & Habgood, J. (2019). UniCraft: Exploring the impact of asynchronous multiplayer game elements in gamification. *International Journal of Human-Computer Studies*, 127, 150-168. doi: 10.1016/j.ijhcs.2018.05.006

Günther, M., Kacperski, C., & Krems, J. F. (2020). Can electric vehicle drivers be persuaded to eco-drive? A field study offeedback, gamification and financial rewards in Germany. *Energy Research & Social Science*, 63. doi: 10.1016/j.erss.2019.101407

Hsu, C.-L., & Chen, M.-C. (2018). How gamification marketing activities motivate desirable consumer behaviors: Focusing on the role of brand love. *Computers in Human Behavior*, 88, 121-133. doi: 10.1016/j.chb.2018.06.037

Kilbourne, W., & Pickett, G. (2008). How materialism affects environmental beliefs, concern, and environmentally responsible behavior. *Journal of Business Research*, 61(9), 885-893. doi: 10.1016/j.jbusres.2007.09.016

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, 45, 191-210. doi: 10.2139/ssrn.3226221

Lindenberg, S., & Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. *Journal of Social Issues*, 63(1), 117-137. doi: 10.1111/j.1540-4560.2007.00499.x

Liu, D., Santhanam, R., & Webster, J. (2017). Toward meaningful engagement: A framework for design and research of gamified information systems. *MIS Quarterly*, 41(4). doi: 10.25300/MISQ/2017/41.4.01

Moro, S., Ramos, P., Esmerado, J., & Jalali, S. M. J. (2019). Can we trace back hotel online reviews' characteristics using gamification features?. *International Journal of Information Management*, 44, 88-95. doi: 10.1016/j.ijinfomgt.2018.09.015

Papaioannou, T. G., Hatzi, V., & Koutsopoulos, I. (2018). Optimal design of serious games for consumer engagement in the smart grid. *IEEE Transactions on Smart Grid*, 9(2), 1241-1249. doi: 10.1109/TSG.2016.2582298

Steinhorst, J., & Klöckner, C. A. (2017). Effects of monetary versus environmental information framing: Implications for long-term pro-environmental behavior and intrinsic motivation. *Environment and Behavior*, 50(9), 997-1031. doi: 10.1177/0013916517725371

Suh, A., Cheung, C. M., Ahuja, M., & Wagner, C. (2017). Gamification in the workplace: The central role of the aesthetic experience. *Journal of Management Information Systems*, 34(1), 268-305. doi: 10.1080/07421222.2017.1297642

Suh, A., & Wagner, C. (2017). How gamification of an enterprise collaboration system increases knowledge contribution: An affordance approach. *Journal of Knowledge Management.* doi: 10.1108/JKM-10-2016-0429

Sun, H., Teh, P. L., & Linton, J. D. (2018). Impact of environmental knowledge and product quality on student attitude toward products with recycled/remanufactured content: Implications for environmental education and green manufacturing. *Business Strategy and the Environment*, 27(7), 935-945. doi: 10.1002/bse.2043

Tobon, S., Ruiz-Alba, J. L., & García-Madariaga, J. (2020). Gamification and online consumer decisions: Is the game over?. *Decision Support Systems*, 128, 113167. doi: 10.1016/j.dss.2019.113167

Trautwein, U., Marsh, H. W., Nagengast, B., Lüdtke, O., Nagy, G., & Jonkmann, K. (2012). Probing for the multiplicative term in modern expectancy–value theory: A latent interaction modeling study. *Journal of Educational Psychology*, 104(3), 763-777. doi: 10.1037/a0027470

Werbach, K., & Hunter, D. (2012). For the win: How game thinking can revolutionize your business. Wharton digital press.

Wigfield, A., Eccles, J. S., & Pintrich, P. R. (1996). Development between the ages of ll and 25. *Handbook of Educational Psychology*, 148.

Wittenberg, I., Blöbaum, A., & Matthies, E. (2018). Environmental motivations for energy use in PV households: Proposal of a modified norm activation model for the specific context of PV households. *Journal of Environmental Psychology*, 55, 110-120. doi: 10.1016/j.jenvp.2018.01.002

Yang, X., Chen, S. C., & Zhang, L. (2020). Promoting sustainable development: A research on residents' green purchasing behavior from a perspective of the goal - framing theory. *Sustainable Development*, 28(5), 1208-1219. doi: 10.1002/sd.2070