Optimal Gamification Design in E-commerce Platform

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Abstract
Gamification is widely applied in e-commerce platforms to make consumers’ shopping process more entertaining. This paper develops an analytical model to examine the effects of different gamification designs on consumers’ purchasing behaviors and the profit of e-commerce platforms. We consider four scenarios according to whether the platform provides aesthetics design (or not) and guidance design (or not) on the basis of reward-based gamification. The results show that the platform should offer aesthetic features regardless of guidance design. In addition, the platform’s gamification strategy depends on the guidance design-related technology cost. When the technology cost is relatively low, providing both guidance design and aesthetics is the best choice, and the platform and consumers can achieve a win-win outcome; while providing aesthetics but not guidance design is the best option when the technology cost is relatively high.

Keywords: Gamification, E-commerce platform, Consumer surplus, Analytical model

1. Introduction
As a new paradigm in the digital age of marketing, many business industries have introduced gamified systems to provide consumers with unique hedonic experience (Tobon et al., 2020). A gamified system, also referred to as gamification, represents incorporating game design elements into a target non-game system (Liu et al., 2017). The current hype of gamification has enticed many online business industries to apply it to real-world marketing practice. A survey stated that 87% of the responding business industries expected to integrate gamification into their business platforms by 2020 (Högberg et al., 2019). Gamification has been proven successful with promotional campaigns targeting consumers in the online marketplaces (Tobon et al., 2020). For example, Taobao, Alibaba’s leading e-commerce platform, uses gamification to improve consumer experience and drive substantial sales growth.

Previous research has empirically investigated the impacts of gamification on consumer utility and consumer retention (Högberg et al., 2019; Hsu & Chen, 2018; Jang et al., 2018; Li, 2018; Zhang et al., 2020). Particularly, reward-based gamification is a primary gamification mechanism widely adopted by business industries. Reward-based gamification refers to the gamified system that affords consumers an opportunity to obtain rewards (e.g., points and awards) when they complete predesigned tasks (Zhang et al., 2020). In addition to reward-based gamification, business industries can also add mystery, surprise, and discovery to create aesthetics (see Figure 1, Hofacker et al., 2016). All of these aesthetic features are characteristics of the game gestalt, or creative vision, which generate a mentally immersive experience through in-depth storytelling or virtual game worlds (Aldemir et al., 2018). Moreover, the increased interface complexity may bring consumers hassle cost (Hofacker et al., 2016), and e-commerce platforms have started to use guidance design mechanisms in place to effectively guide consumers’ gameplay and support their purchase activities. For instance, Taobao added guidance design to tell consumers how to complete the task step by step (see Figure 2). Guidance design mechanisms can inspire users’ understanding with the game task (i.e., a target
aesthetics) and shopping activities. In view of this business practice, we consider the two specific gamification design features, i.e., aesthetics and guidance. In addition to the benefits of gamification mechanism, the e-commerce platform also needs to bear the relevant costs, such as design costs for aesthetics and guidance. Therefore, e-commerce platforms need to balance the benefits and costs when adopting gamification. Obviously, whether to adopt aesthetics or guidance design is the key issue that needs to be considered when introducing gamification into e-commerce platform. However, previous literature mostly focus on reward-based gamification (eMarketer, 2016), while neglecting other game design elements (e.g., aesthetics or guidance design) that can be used to create a more game-like experience.

Given the increased popularity of adding aesthetic and guidance features into reward-based gamification, the effectiveness of gamification design and its impact on the profits of e-commerce platforms/firms remains an under-investigated research question. In order to fill in the research gap, we develop an analytical model in which an e-commerce platform sells a product to consumers under different gamification designs. We derive the optimal design level of gamification under different strategies. Moreover, we identify the conditions under which the e-commerce platform and consumer can achieve a win-win outcome.

The remainder of this study is organized as follows. Section 2 describes the model. Section 3 analyzes the e-commerce platform’s optimal gamification design. Section 4 concludes the paper. Note that due to space limitations, proof of propositions is not provided.

2. Model

We consider an e-commerce platform selling a product to consumers at price \( p \). The platform decides the differential design of gamification to improve the consumer shopping experience and thereby increase expected profit. Given that reward is the most basic game design element, the platform implements reward-based gamification by giving consumers points that can be redeemed when shopping. In addition, to further improve the consumer shopping experience, the platform is faced with whether to introduce aesthetic features and guidance design. Note that with adding aesthetic features, the platform (like TaoBao) designs “cat” feature consistently in the logo, the icon, to emphasize that its gamification is a character-centric game. While guidance design enlightens a consumer by providing additional information (e.g., navigating taskbar) pertinent to the game task and shopping activities. The
design of gamification leads to four scenarios: Scenario \( \bar{A}G \), Scenario \( A\bar{G} \), Scenario \( \bar{A}G \), and Scenario \( AG \). For example, Scenario \( \bar{A}G \) denotes that the platform does not introduce aesthetic features and guidance design.

In this paper, we use point \( \phi \) to denote the number of points in reward-based gamification, and use \( e \) to denote the design level of aesthetics. Given that one unit of points can be redeemed for \( \lambda \) units of currency, the platform’s cost of reward-related gamification is \( \lambda \phi \). The platform’s cost of providing aesthetics at a level of \( e \) can be denoted as \( f(e) \), where \( f(0) = 0 \), \( f'(e) > 0 \) and \( f''(e) > 0 \). Following related operations management and economics literature (e.g., Ofek et al., 2011), we assume that the cost of aesthetics is quadratic in the design level, i.e., \( f(e) = he^2/2 \), where \( h \) is a cost coefficient. This well reflects the relationship between the aesthetics design level and cost involved, that is, a higher aesthetics design level indicates a notably higher cost. In addition, the platform needs to bear the cost of guidance design. Compared with aesthetic design, navigation design is relatively simple, which enables consumers to know how to complete the game task. Therefore, we assume that the design level of navigation is fixed and the cost is \( T \). Other costs are assumed to be zero, which is commonly used in the related literature (e.g., Kireyev et al., 2017).

We next model consumer utility from buying a product on the platform under different scenarios. First, consumers vary in their valuation for the product. We assume consumer valuation \( v \) for the product is random and follows a uniform distribution from the interval \([0,1]\). Second, we use \( \gamma \) and \( \delta \) to denote the consumer sensitivity coefficient to the reward (point) and the aesthetics design level, respectively, where \( \gamma > 0 \) and \( \delta > 0 \). More specifically, unit point and aesthetics design level will bring consumers the utility \( \gamma \phi \) and \( \delta e \), respectively. Third, the consumers will incur a hassle cost \( t \) if there is no guidance design. The consumer chooses whether to buy the product based on the utility. In Scenario \( \bar{A}G \), Scenario \( A\bar{G} \), Scenario \( \bar{A}G \), and Scenario \( AG \), the expected utilities a consumer can obtain are \( U_{\bar{A}G} = v - p + \gamma \phi - t \), \( U_{A\bar{G}} = v - p + \gamma \phi + \delta e - t \), \( U_{\bar{A}G} = v - p + \gamma \phi \) and \( U_{AG} = v - p + \gamma \phi + \delta e \), respectively.

2.1 Scenario \( \bar{A}G \)

In Scenario \( \bar{A}G \), the platform only implements reward-related gamification, i.e., provides points for consumers who participate in the game. Both aesthetics and guidance design are not provided. A consumer will buy the product if \( U_{\bar{A}G} = v - p + \gamma \phi - t \geq 0 \); otherwise, he/she will not make a purchase. The platform’s expected profit in this scenario is as follows:

\[
\pi_{\bar{A}G} = (p - \gamma \phi)(1 - p + \gamma \phi - t). \tag{1}
\]

The total consumers surplus in Scenario \( \bar{A}G \) is given as

\[
CS_{\bar{A}G} = \int_{p-\gamma \phi+ t}^{1} (v - p + \gamma \phi - t)dv. \tag{2}
\]

We can derive the optimal number of points \( \phi^*_{\bar{A}G} \) by solving the first-order condition of Eq. (1). And then, by inserting \( \phi^*_{\bar{A}G} \) in Eqs. (1) and (2), we can obtain the platform profit and consumer surplus. The optimal solutions are shown in Table 1.

2.2 Scenario \( A\bar{G} \)

In this scenario, the e-commerce platform designs aesthetics. Consumer can not only acquire the points, but also obtain the enjoyment of participating in a character-centric game.
(adding aesthetics). Given that the platform does not provide guidance design, consumers will incur a hassle cost when experiencing the game. A consumer who purchases the product in this scenario can obtain a surplus $U_{\tilde{A}G} = v - p + \gamma \phi + \delta e - t$. If $U_{\tilde{A}G} \geq 0$, he/she will make a purchase. Given that the platform provides aesthetics, the expected profit in this scenario is

$$\pi_{\tilde{A}G} = (p - \gamma \phi)(1 - p + \gamma \phi + \delta e - t) - he^2/2.$$  

The total consumers surplus in Scenario $\tilde{A}G$ is given as

$$CS_{\tilde{A}G} = \int_{p - \gamma \phi}^{1}(v - p + \gamma \phi + \delta e - t)dv.$$  

### 2.3 Scenario $\tilde{A}G$

In Scenario $\tilde{A}G$, the e-commerce platform does not design aesthetics, but provides guidance design which helps consumers know how to proceed to get points during interactions with the gamified system. The consumer surplus in this scenario is $U_{\tilde{A}G} = v - p + \gamma \phi$. If $U_{\tilde{A}G} \geq 0$, he/she will buy the product. Since the platform provides guidance design, the expected profit in this scenario is presented as

$$\pi_{\tilde{A}G} = (p - \gamma \phi)(1 - p + \gamma \phi) - T.$$  

The total consumers surplus in Scenario $\tilde{A}G$ is

$$CS_{\tilde{A}G} = \int_{p - \gamma \phi}^{1}(v - p + \gamma \phi)dv.$$  

### 2.4 Scenario $AG$

In Scenario $AG$, the e-commerce platform provides both aesthetics and guidance design. The consumer surplus in this scenario is $U_{AG} = v - p + \gamma \phi + \delta e$. If $U_{AG} \geq 0$, he/she will buy the product. The platform’s expected profit in this scenario is as follows:

$$\pi_{AG} = (p - \gamma \phi)(1 - p + \gamma \phi + \delta e) - he^2/2 - T.$$  

The total consumers surplus in Scenario $AG$ is

$$CS_{AG} = \int_{p - \gamma \phi}^{1}(v - p + \gamma \phi + \delta e)dv.$$  

Similarly, the equilibrium solutions can be obtained and are shown in Table 1.

**Table 1.** The equilibrium solutions under different scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>$\phi^*$</th>
<th>$e^*$</th>
<th>$\pi^*$</th>
<th>$CS^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tilde{A}G$</td>
<td>$\frac{yp - \lambda(1 - p - t)}{2\lambda \gamma}$</td>
<td>$n.a$</td>
<td>$\frac{(yp + \lambda(1 - p - t))^2}{4\lambda \gamma}$</td>
<td>$\frac{(yp + \lambda(1 - p - t))^2}{8\lambda^2}$</td>
</tr>
<tr>
<td>$\tilde{A}G$</td>
<td>$\frac{h(yp - \lambda(1 - p - t)) - \lambda p \delta^2}{2\gamma h - \lambda \delta^2}$</td>
<td>$\frac{\delta(yp + \lambda(1 - p - t))}{2\gamma h - \lambda \delta^2}$</td>
<td>$\frac{h(yp + \lambda(1 - p - t))^2}{4\lambda\gamma h - \lambda \delta^2 - 2\gamma}$</td>
<td>$\frac{1}{8}\left[\frac{hp(yp + \lambda(1 - p - t))}{\lambda(\gamma h - \lambda \delta^2/2)}\right]^2$</td>
</tr>
<tr>
<td>$\bar{A}G$</td>
<td>$\frac{yp - \lambda(1 - p)}{2\lambda \gamma}$</td>
<td>$n.a$</td>
<td>$\frac{(yp + \lambda(1 - p))}{4\lambda \gamma} - T$</td>
<td>$\frac{(yp + \lambda(1 - p))^2}{8\lambda^2}$</td>
</tr>
<tr>
<td>$AG$</td>
<td>$\frac{h(yp - \lambda(1 - p)) - \lambda p \delta^2}{2\gamma h - \lambda \delta^2}$</td>
<td>$\frac{\delta(yp + \lambda(1 - p))}{2\gamma h - \lambda \delta^2}$</td>
<td>$\frac{h(yp + \lambda(1 - p))^2}{4\lambda\gamma h - \lambda \delta^2 - 2\gamma} - T$</td>
<td>$\frac{1}{8}\left[\frac{hp(yp + \lambda(1 - p))}{\lambda(\gamma h - \lambda \delta^2/2)}\right]^2$</td>
</tr>
</tbody>
</table>

### 3. Analysis

In this section, we first examine the platform’s optimal gamification strategy and expected profits, and then compare consumer surplus under four scenarios.
3.1 Optimal gamification strategy

Proposition 1. The equilibrium outcomes satisfy:
(i) \( \phi^*_\text{AG} > \max \{ \phi^*_\text{AG}^{+}, \phi^*_\text{AG}^{-} \} > \phi^*_\text{AG} \), and if \( t \geq (\gamma p + (1-p)\lambda)\delta^2/(2h\gamma) \), we have \( \phi^*_\text{AG} \geq \phi^*_\text{AG}^{+} \); otherwise \( \phi^*_\text{AG} < \phi^*_\text{AG}^{-} \).
(ii) \( e^*_\text{AG} < e^*_\text{AG} \).

Proposition 1(i) shows that the e-commerce platform should offer more points to consumers under the scenario with only reward-based gamification; on the contrary, the platform can offer less points to consumers when providing both aesthetics and guidance design. More specifically, when the hassle cost of a consumer participating in the game is relatively large, it’s better for the platform to provide more points under scenario \( \text{AG} \) than that under the scenario \( \text{AG}^{-} \). Proposition 1(ii) presents that the platform should provide a higher design level of aesthetics when guidance design exists compared with no guidance design.

Proposition 2. The profits of the e-commerce platform under four scenarios have the following relationships:
(i) If \( T < T_1 \), we have \( \pi^*_\text{AG} > \max \{ \pi^*_\text{AG}^{+}, \pi^*_\text{AG}^{-} \} > \pi^*_\text{AG} \);
(ii) If \( T_1 \leq T < T_2 \), we have \( \pi^*_\text{AG} > \pi^*_\text{AG}^{+} > \pi^*_\text{AG}^{-} \geq \pi^*_\text{AG} \);
(iii) If \( T \geq T_2 \), we have \( \pi^*_\text{AG} > \max \{ \pi^*_\text{AG}^{+}, \pi^*_\text{AG}^{-} \} > \pi^*_\text{AG} \).

Note that \( T_1 = t((1-p-t/2)\lambda + \gamma p)/(2\gamma) \) and \( T_2 = th((1-p-t/2)\lambda + \gamma p)/(2\gamma h - \lambda \delta^2) \).

Proposition 2 shows that regardless of whether guidance design is provided or not, the e-commerce platform should offer aesthetics because it can bring consumers an additional shopping experience. In addition, the platform’s gamification strategy depends on the guidance design-related technology cost. When the technology cost is relatively low, providing both guidance design and aesthetics is the best choice; in contrast, providing aesthetics but not guidance design is the best option.

3.2 Consumer surplus

Proposition 3. Consumer surplus under four scenarios have the following relationships:
(i) \( CS^*_\text{AG} > \max \{ CS^*_\text{AG}^{+}, CS^*_\text{AG}^{-} \} > CS^*_\text{AG} \);
(ii) If \( t \geq (\gamma p + (1-p)\lambda)\delta^2/(2h\gamma) \), we have \( CS^*_\text{AG} \geq CS^*_\text{AG}^{+} \); otherwise \( CS^*_\text{AG} > CS^*_\text{AG}^{-} \).

Proposition 3 indicates that consumer can obtain the most surplus in the scenario where both aesthetics and guidance design are provided, but get the least surplus when only reward-based gamification is provided. In addition, when the hassle cost of participating in game is relatively high, consumers will get less surplus if the platform offers aesthetics but not guidance design. In this case, guidance design can bring more consumer surplus than aesthetics.

4. Conclusion

This paper develops an analytical model to examine the effects of differential gamification designs on consumer purchasing behavior and the profit of e-commerce platform. The major managerial insights are demonstrated as follows. First, the e-commerce platform should offer more reward-based gamification mechanisms (i.e., gamification points) to consumers if it does
not provide aesthetics. Second, the e-commerce platform should also improve the aesthetics level if it provides guidance design, that is, gamification designers have to seek a “sweet spot” of the balance between aesthetics design and guidance design. Specifically, providing guidance design can decrease the difficulty of getting rewards, whereas providing aesthetics can increase the difficulty level. As such, there needs a balance between them to ensure an appropriate difficulty level at which a reward is given. Third, regardless of whether guidance design is provided or not, the e-commerce platform should offer aesthetics design on the basis of reward-based gamification. Finally, the e-commerce platform and consumer can achieve a win-win outcome if both aesthetics and guidance design are provided when the technology cost of the e-commerce platform is relatively low; while providing aesthetics but not guidance design is the best option for the e-commerce platform when the technology cost is relatively high. Future research can extend our study by introducing multi-product and platform competition, which will lead to more interesting findings.

References