

Contemporaneous effects of gamified reward specificity on knowledge contribution: Evidence from a Q&A community

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Abstract

This study investigates the contemporaneous effects of virtual badges on knowledge contribution in a Question and Answer (Q&A) community. Drawing on regulatory fit theory, we propose a conceptual framework of gamified reward specificity to explain how winning some types of badges can stimulate users' contemporaneous knowledge contributions more likely than others. This study empirically assesses such contemporaneous effects by conducting logistic regression analyses on the data collected from Stack Overflow. Our findings suggest that attaining a specific badge can increase users' contemporaneous knowledge contributions related to that badge while earning a non-specific badge can decrease such contemporaneous contributions. These findings contribute a new perspective to the existing literature and address overlooked aspects of gamification practices, offering innovative insights into designing gamified reward systems more effectively in Q&A communities.

Keywords: Contemporaneous knowledge contribution, gamified reward specificity, Q&A community, regulatory fit theory, virtual badge.

Introduction

Question and Answer (Q&A) communities are online places where users can seek and share expert knowledge (Wang & Hung, 2019; Zhou, 2022). A widely accepted belief is that incentives can motivate individuals' engagement and actions; many online communities now offer monetary or gamified rewards to encourage users to create and share User-Generated Content (UGC). Zhihu, a prominent Q&A community in China, uses financial rewards to incentivize its users to host live Q&A sessions for knowledge-sharing (Kuang et al., 2019; Wang et al., 2022). Also, Reddit employs gamified rewards, including trophies and gold awards, to acknowledge users who have contributed to the online community and to encourage them to continue making valuable contributions in the future (Burtch et al., 2022). Both monetary and non-monetary incentives influence user contributions in online communities; however, this study specifically focuses on gamified rewards. While extant literature (e.g., Cavusoglu et al., 2021; Goes et al., 2016; Kuang et al., 2019; Yanovsky et al., 2021) provided valuable insights into the effects of virtual rewards in general, it remains unclear whether a specific type of gamified reward can stimulate contemporaneous knowledge contribution more effectively than others. In this vein, we defined gamified reward specificity as the degree to which a gamified reward (e.g., badge) is tailored or

specific to a particular behavior (e.g., posting answers or questions). Gamified reward specificity is vital to consider as it is commonly assumed that the success of gamification depends on its diversification of incentives (Liu et al., 2017). Yet, specific rewards can be more effective in promoting a particular behavior than general rewards. For example, a reward explicitly given for performing a set of activities may be more motivating than a reward offered for completing other activities. Thus, studying gamified reward specificity can be helpful in online communities where specific kinds of UGC need to be encouraged or reinforced. To illustrate, a Q&A community can leverage reward specificity to incentivize knowledge-sharing or knowledge-seeking behaviors to better manage the balance between the two. Notwithstanding the critical role played by gamified reward specificity in shaping individual behaviors, to the best of our knowledge, limited effort has been devoted to exploring how it can motivate or hinder users' contemporaneous knowledge contributions in Q&A communities.

To address the backdrop, we focus on badge specificity as a representative form of gamified reward specificity, and we examine how it can affect users' contemporaneous knowledge contribution in a gamified Q&A community in this study. Accordingly, this study answers a key research question: How can some badge types motivate the contemporaneous knowledge contribution more effectively than others in the Q&A community? In our research, contemporaneous knowledge contribution refers to how quickly a user posts an answer or question after attaining a badge (e.g., within the next 24 hours). We focused on contemporaneous knowledge contribution because it can inform online communities about whether gamified reward specificity can quickly create a positive feedback loop of engagement to cope with the sporadic imbalance among different types of UGC (e.g., more questions than answers or vice versa). In this vein, regulatory fit theory (Higgins et al., 2010) is utilized to theorize the contemporaneous effects of badge reward specificity on knowledge contribution. This theory posits that individuals perceive an increased value in an activity and are more inclined to revisit specific tasks when they experience a regulatory fit, such as being awarded for pursuing gains. For example, by attaining a reward for past activities, the person can perceive a regulatory fit between the activities and the earned reward, motivating individuals to continue performing the activities in the future. Our conceptualization suggests that in a Q&A community, a user awarded a badge for asking questions is more inclined to engage in knowledge-seeking activities than knowledge-sharing ones. Conversely, a user awarded a badge for sharing answers is more motivated to engage in knowledge-sharing activities over knowledge-seeking ones. In this vein, gamified reward specificity is essential in sustaining or disrupting a user's contemporaneous knowledge contribution.

To test our conceptualization of badge specificity, we designed our study to focus on three major categories of badges currently offered by Stack Overflow, including question, answer, and participation badges; each incentivizes a specific set of activities meaningful to the community. Question badges are designed to incentivize knowledge-seeking, whereas answer badges are designed to incentivize knowledge-sharing. While both question and answer badges are rewards specific to incentivize a particular set of activities, participation badges are non-specific rewards intended for general purposes, such as completing user profiles, moderator elections, posting comments, visiting the site, earning reputation points, etc. Due to their unique characteristics, participation badges can serve as a perfect baseline reference group for us to observe gamified reward specificity's effects by separating different badges into three levels (e.g., answer-specific,

question-specific, and neutral). In other words, we examine how answer-specific and question-specific badges can affect contemporaneous knowledge contribution by comparing them to participation badges.

The rest of this paper is organized as follows. In the 2nd section, we review the related literature to our study. In the 3rd section, we present our theoretical foundation and hypotheses to explain how badge specificity influences users' contemporaneous knowledge contribution. In the 4th section, we discuss our study design and data; in the 5th section, we report our analysis results. We conclude this study by discussing the implications based on our findings in the last section.

Literature Review

Two research streams are closely related to our study (see Appendix A). The first research stream's central tenet is to identify internal factors that motivate users' knowledge contributions. Two motivators that encourage users to contribute knowledge internally are knowledge self-efficacy and enjoyment in helping others (Jin et al., 2013; Lou et al., 2013; Wasko & Faraj, 2005; Zhao et al., 2016). Other important intrinsic factors have also been studied, such as habits (Khansa et al., 2015) and user-community commitment (Bateman et al., 2011), egoistic motive (Yu et al., 2011), and satisfaction (Jin et al., 2013). The second research stream focuses on the impacts of gamified rewards in online communities. Extant literature has investigated various kinds of gamified rewards, such as points (Dong et al., 2020; Zimmerling et al., 2019), reputation (Chen et al., 2022; Wei et al., 2015), level based on accumulated points (Dong et al., 2020; Goes et al., 2016), badges (Anderson et al., 2013; Cavusoglu et al., 2021; Chen et al., 2022; Wei et al., 2015; Yanovsky et al., 2021; Zimmerling et al., 2019), status (Bhattacharyya et al., 2020; Zhang et al., 2020), and community user privilege (Burtch et al., 2022; Chen et al., 2022). These reported studies found mixed results. In addition, some studies (Cavusoglu et al., 2021; Chen et al., 2022) reveal that providing gamified rewards can increase knowledge contribution; others (Bhattacharyya et al., 2020; Burtch et al., 2022; Dong et al., 2020; Goes et al., 2016; Wei et al., 2015; Yanovsky et al., 2021; Zhang et al., 2020; Zimmerling et al., 2019) indicate that the effects may vary depending on the types of gamified rewards.

After carefully reviewing the existing literature, we believe this paper can contribute to knowledge in several ways. First, limited research has investigated how gamified reward specificity affects knowledge contribution. Thus, to the best of our knowledge, this study is among the first few research studies to explore this topic. This is an important area of inquiry, as online communities often rely on various rewards to build and maintain a vibrant and valuable knowledge-sharing platform. By understanding how gamified reward specificity can motivate and incentivize knowledge contributions, community operators can better design and implement incentive structures that promote user engagement and collaboration to attract more traffic. Second, limited research examines the impact of badge attainment on knowledge-seeking activities. Most studies in this domain have focused on incentivizing knowledge-sharing activities, such as posting answers while knowledge-seeking has been neglected. Knowledge-seeking is an essential component of knowledge contribution in Q&A communities. Without knowledge-seekers, knowledge-sharing would have limited value. Therefore, it is necessary to understand how badge specificity can motivate knowledge-seeking in conjunction with knowledge-sharing. Third, most

prior studies evaluate the effect of gamified rewards by considering the aggregation of knowledge contributions over a certain period, while the influence of attaining badges on users' contemporaneous knowledge contributions in online communities is largely overlooked. The impacts of gamified rewards on contemporaneous knowledge contribution are important because individuals' impulsivity can reflect the motivational strength of badge attainments more accurately (Anderson et al., 2013).

Theory and Hypotheses

The contemporaneous effects of badge specificity on knowledge contribution can be understood using regulatory fit theory (Higgins, 2000). This theory suggests that people sense a higher value of an activity and are more interested in repeating specific activities when they experience the regulatory fit that affects their past activities by offering rewards. A common approach to induce regulatory fit is to utilize external incentives to fit a person's activity orientations. As Higgins et al. (2010) stated, "When the situation surrounding an activity supports a manner of engagement that sustains people's orientation to the activity (a fit), interest in doing the activity again will be stronger than when the surrounding situation supports a manner of engagement that disrupts people's orientation (a nonfit)" (p. 570). In this vein, activity orientation refers to an individual's understanding of the goal or value that a subsequent activity can provide.

In online Q&A communities, activity orientations are primarily determined by two major activities users can perform: knowledge-seeking and knowledge-sharing. These two activities lay the foundation and create values for one to use in a Q&A community (Kuang et al., 2019). Consequently, badge attainments can demonstrate either a fit or a nonfit for the two activities. For example, earning an answer badge may help users sustain their activity orientations toward knowledge-sharing by developing "a feeling of rightness" for future answering activities (Higgins et al., 2010). This is because a particular badge can have a specific symbolic meaning for a community user to frame a better self-image in a particular domain (Cavusoglu et al., 2021). Moreover, receiving a badge for completing an activity can provide a sense of accomplishment and recognition, increasing users' self-esteem and reinforcing their motivation to engage in similar activities later. Badges serve as a tangible and visible representation of one's achievements, which can help satisfy individuals' basic psychological needs for competence, autonomy, and relatedness (Cavusoglu et al., 2021). Existing research also indicates that rewards tailored to a specific activity can align more effectively with individuals' intrinsic motivations toward that activity. For example, Chen et al. (2018) found that users who received monetary incentives for writing investment articles wrote more articles. Thus, attaining an answer-specific badge should produce a high degree of regulatory fit to motivate users to engage in subsequent knowledge-sharing activities rather than non-specific badges. Similarly, acquiring a question-specific badge can sustain one's orientation toward knowledge-seeking activity more than non-specific badges could. Thus, we hypothesize:

- *H1a: Compared to attaining neutral badges (e.g., participation badge), attaining answer-specific badges will increase the probability of a user contributing to knowledge-sharing within a day (next 24 hours) of badge attainment.*

- *H1b: Compared to attaining neutral badges (e.g., participation badge), attaining question-specific badges will increase the probability of a user contributing to knowledge-seeking within a day (next 24 hours) of badge attainment.*

A specific reward that sustains one activity may not produce the regulatory fit for another. To illustrate, question-specific does not fit well with one’s orientation toward knowledge-sharing activity. As the regulatory fit is reduced, the chances for users attaining question-specific (answer-specific) badges to perform subsequent knowledge-sharing (seeking) activities decrease. Thus, we hypothesize:

- *H2a: Compared to attaining neutral badges (e.g., participation badge), attaining answer-specific badges will decrease the probability of a user contributing to knowledge-seeking within a day (next 24 hours) of badge attainment.*
- *H2b: Compared to attaining neutral badges (e.g., participation badge), attaining question-specific badges will decrease the probability of a user contributing to knowledge-sharing within a day (next 24 hours) of badge attainment.*

Study Context and Data

Our research context is a popular Q&A community for IT professions in the United States, Stack Overflow, with over 14 million registered users. Gamified reward systems such as badges have been implemented since the creation of Stack Overflow. As shown in Table 1 below, we focus on three major badge types rewarded to community users: question, answer, and participation badges. Unlike other Q&A communities primarily facilitating social networks, Stack Overflow exclusively focuses on promoting Q&A activities by not adopting any social-network-like features, such as following and private message functions.

Table 1. Three Major Badge Categories of Knowledge Contributions

Badge	Description
Question Badge	Badges awarded to Question-related achievements.
Answer Badge	Badges awarded to Answer-related achievements.
Participation Badge	Badges awarded for Participation-related achievements.

Observation Window

We evaluated the contemporaneous impact of badge specificity on knowledge contribution by collecting community activity data for 2019, such as badge attainments, answer posts, and question posts. We chose the year 2019 because it would help us avoid any confounding effects induced by the COVID-19 pandemic in 2020. The unit of our analysis is at badge attainment level, including badge *i* rewarded at time *t* and its impact on the subsequent knowledge contributions.

Dependent Variable

To capture the contemporaneous effects of gamified rewards on knowledge contribution, we designed dependent variables that captured whether the subsequent question or answer activity was made within 24 hours after a badge was attained. Table 2 below lists our dependent variables.

Table 2. Dependent Variables

Variables	Description
Answer24hrs	Whether (1=yes) or not (0=no) a user contributes an answer post within a day (next 24 hours) after a badge was awarded to the user.
Question24hrs	Whether (1=yes) or not (0=no) a user contributes a question post within a day (next 24 hours) after a badge was awarded to the user.

Independent Variables

Our independent variables were two binary variables based on badge specificity, with one indicating answer-specific badge attainment and another indicating question-specific badge attainment. Table 3 details our coding scheme for these two binary variables. Table 4 lists control variables in our analyses, primarily derived from previous research. To illustrate, the inclusion of *MultipleAward* aligns with findings from Bhattacharyya et al. (2020), while badge levels (e.g., *Silver*, *Gold*) follow the work of Cavusoglu et al. (2021). Additionally, given that badges can be awarded at various times, we incorporated *WeekDayUTC* and *BeginDayUTC* to control for potential confounding effects.

Table 3. Binary Coding Scheme for Independent Variables

Categories of Badge	Answer-specific Attainment	Question-specific Attainment
Answer Badge	1	0
Question Badge	0	1
Participation Badge	0	0

Note: The values (0 and 0) for the participation badge indicate that a badge attainment event in our dataset is not tied to an answer-specific or a question-specific badge, serving as a baseline data point in our analyses.

Table 4. Control Variables

Variables	Description
MultipleAward	Whether the badge can be rewarded multiple times: 1 multiple, 0 only once.
Silver	Whether the badge rewarded is silver class: 1 or 0.
Gold	Whether the badge rewarded is gold class: 1 or 0.
WeekDayUTC	Whether the badge rewarded is on a weekday based on Coordinated Universal Time (UTC): 1 weekday, 0 weekend.
BeginDayUTC	Whether the badge rewarded is at the beginning of a day between 0:00 am and 6:00 am based on Coordinated Universal Time (UTC): 1 yes, 0 no.

Summary Statistics

In total, our data contains 3,264,621 badge attainments for 1,439,001 unique users. Table 5 details the count statistics of our sample. Interestingly, Table 5 indicates that more question badges were awarded to users in 2019 than answer badges. This suggests that either question badges are more

accessible to attain, or users are more inclined to ask than answer, resulting in greater attainment of question badges.

Table 5. Count Statistics of the Sample

Variables	Total Number of Occurrences
Answer24hrs	116,604
Question24hrs	58,505
Answer badge attainment	608,690
Question badge attainment	1,655,782
Participation badge attainment	1,000,149
MultipleAward	2,316,340
Silver	1,228,504
Gold	121,377
WeekDayUTC	2,782,859
BeginDayUTC	548,702

Empirical Analyses

In this section, we first conduct two exploratory analyses to showcase how different types of badge attainments can affect subsequent contributions to knowledge-seeking and sharing activities. We then show the main analyses to test our hypotheses, followed by two ex-post analyses to test how the observed effects may further differ across multiple user groups and repeated badges.

Exploratory Analyses

Figure 1 shows the dynamic impact of badge-rewarding on the subsequent knowledge-sharing activity for each category of badge attainment. We denote contemporaneous knowledge-sharing as the next knowledge-sharing activity that occurred within 24 hours (1 day) of badge attainment at T1 and delayed knowledge-sharing activity at T2, ..., and T10 in the subsequent days. In line with the steering effect, which posits that users often reduce their knowledge contributions over time after receiving a badge (Anderson et al., 2013; Yanovsky et al., 2021), we also observed a decline in knowledge contributions after the badge attainments. Attaining answer badges spurs a peak in knowledge-sharing activities within the first 24 hours (T1), yet a noticeable drop in contributions over the following days (T2 to T10).

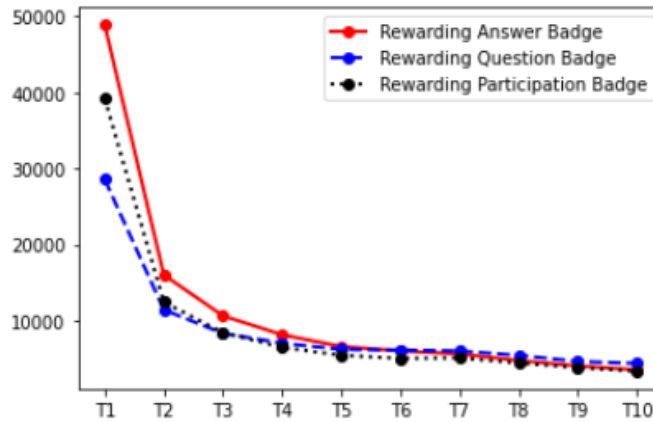


Figure 1. Effect of Badge Rewarding on Subsequent Knowledge-sharing Activity

Similarly, Figure 2 reports the subsequent knowledge-seeking activity resulting from different badge attainments. There is a noticeable difference in users’ knowledge-seeking activity after being awarded badges. Specifically, when users are granted question badges, there is a more pronounced decrease in knowledge-seeking activity over 10 days after the badge attainment. In contrast, those awarded answer badges exhibit the smallest decline in such activity within the same period. This preliminary analysis highlights the significance of badge specificity, focusing on whether a user receives a question or an answer badge. We delve deeper into this observation in our main analysis, which follows.

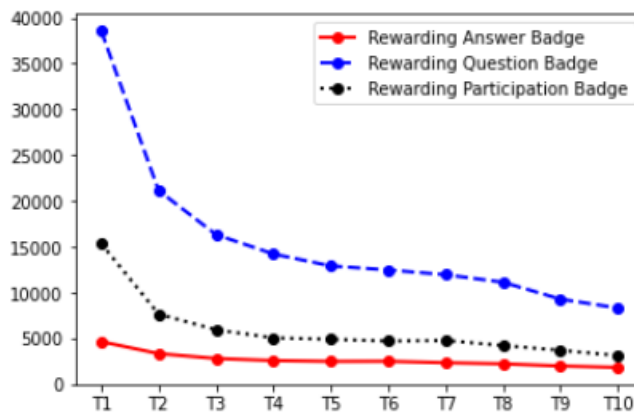


Figure 2. Impact of Badge Rewarding on Subsequent Knowledge-seeking Activity

Model Specification for Main Analysis

As our dependent variables are binary (1=yes or 0=no), we used logistic regression for our hypothesis testing. The model equation is shown as follows:

$$\ln\left(\frac{P(y_{it+1})}{1-P(y_{it+1})}\right) = \beta_0 + \beta_1 \cdot AnsSpec_{it} + \beta_2 \cdot QuesSpec_{it} + \beta_3 \cdot MultipleAward_{it} + \beta_4 \cdot Silver_{it} + \beta_5 \cdot Gold_{it} + \beta_6 \cdot WeekDayUTC_{it} + \beta_7 \cdot BeginDayUTC_{it}$$

y_{it+1} represents two outcome variables for contemporaneous knowledge contribution after a badge attainment, such as $Answer24hrs_{it+1}$ (whether the next answer is posted within 24 hours of a badge attainment) and $Question24hrs_{it+1}$ (whether the next question is posted within 24 hours of a badge attainment). $P(y_{it+1})$ stands for the probability of being in 1 (yes) or 0 (no). $AnsSpec_{it}$ is an indicator of whether the awarded badge is an answer-specific badge, whereas $QuesSpec_{it}$ is an indicator of whether the awarded badge is a question-specific badge. The control variables $MultipleAward_{it}$ and $BeginDayUTC_{it}$ refer to whether the badge can be rewarded multiple times and whether it is rewarded during the beginning of a day from 0 am to 6 am based on Coordinated Universal Time (UTC), respectively. $Silver_{it}$ and $Gold_{it}$ refer to whether the rewarded badge is a silver or a gold badge, respectively. $WeekDayUTC_{it}$ is an indicator to differentiate whether the badge is awarded during a weekday or weekend based on Coordinated Universal Time (UTC).

Main Analysis

We first analyze how badge specificity impacts individuals' contemporaneous knowledge-sharing or knowledge-seeking activities. Table 6 presents the summaries of two separate logistic regression models, and both are statistically reliable in differentiating whether an answer was posted within 24 hours following a badge achievement [-2 Log Likelihood = 922908, $\chi^2(7) = 83160$, $p < 0.001$] and whether a question was posted within 24 hours after receiving a badge [-2 Log Likelihood = 540053, $\chi^2(7) = 46480$, $p < 0.001$]. As we report in Table 6, compared to other badge attainments, awarding an answer-specific badge significantly increases the odds of contemporaneous knowledge-sharing by approximately 106% (i.e., this odds ratio is calculated by $\exp(0.724) - 1$) compared to the baseline of participation badge attainments, supporting our H1a. Similarly, awarding a question-specific badge significantly improves the odds of contemporaneous knowledge-seeking by approximately 40% compared to the baseline, confirming our H1b. Also, the results indicate that the positive effect of gamified reward specificity on knowledge-sharing is greater than knowledge-seeking's. Together, the analysis of results reveals that gamified reward specificity positively affects contemporaneous knowledge contribution.

Conversely, Table 6 shows that gamified reward non-specificity hurts contemporaneous knowledge contribution. Compared to the baseline, awarding an answer-specific badge can significantly reduce the odds of contemporaneous knowledge-seeking by approximately 54%, corroborating our H2a. Correspondingly, awarding a question-specific badge can significantly reduce the odds of contemporaneous knowledge-sharing by approximately 60% compared to the baseline, affirming our H2b. In addition, our findings found that comparing a singular badge rewarded with multiple badges rewarded can significantly lower the odds of making contemporaneous knowledge contributions. Furthermore, awarding silver and gold badges hurts making contemporaneous knowledge contributions in general. Awarding badges on the weekday and at the beginning of the day (based on UTC) also significantly impacts the odds of contemporaneous knowledge contribution. This effect can vary based on a user's location and the season when the badge is attained. For instance, during winter in London, earning badges between 0:00 a.m. and 6:00 a.m. may reduce the odds of users sharing knowledge contemporaneously (within the next 24 hours). Still, it may increase their propensity to seek knowledge compared to

when badges are awarded at other times. Since users can come from diverse time zones, this finding offers exciting paths for future research.

Table 6. Sample Contemporaneous Impact of Gamified Reward Specificity on Knowledge Contribution (N=3,264,621)

	<i>Answer24hrs_{it+1}</i>	<i>Question24hrs_{it+1}</i>
<i>Intercept</i>	-2.503*** (0.010)	-3.313*** (0.014)
<i>AnsSpec_{it}</i>	0.724*** (0.007)	-0.783*** (0.017)
<i>QuesSpec_{it}</i>	-0.917*** (0.008)	0.337*** (0.010)
<i>MultipleAward_{it}</i>	-1.119*** (0.008)	-1.510*** (0.011)
<i>Silver_{it}</i>	-0.097*** (0.009)	-0.322*** (0.015)
<i>Gold_{it}</i>	0.007 ^{ns} (0.021)	-0.328*** (0.032)
<i>WeekDayUTC_{it}</i>	0.044*** (0.008)	0.067*** (0.011)
<i>BeginDayUTC_{it}</i>	-0.017** (0.008)	0.169*** (0.010)

Note: ns = nonsignificant; *p<0.1; **p<0.05; ***p<0.01; standard errors are in parentheses.

Ex-post Analysis

We also report two ex-post analyses to extend the observed main effects in the study. First, we examined whether the impact of gamified reward specificity can be susceptible to user preference. For example, frequent answerers are more sensitive to answer-specific badge attainment and, therefore, have a higher tendency to make contemporaneous knowledge-sharing than others. To unveil this impact, we created two user groups (e.g., frequent answerers/questioners) and ran our main analyses for each group. Specifically, we gathered historical knowledge contributions for each user before the beginning of our study context in 2019. We then calculated the total number of questions and answers posted for each user and subtracted them from one to another. If the value is positive, the user is defined as a questioner who is more likely to perform knowledge-seeking activities; if the value is negative, the user will be defined as an answerer who is more likely to perform knowledge-sharing activities. As shown in Table 7, the results suggest that the observed effects of badge specificity remain significant in most parts. Yet, we notice that the positive effects of badge specificity on contemporaneous knowledge contribution are more substantial for the frequent answerer group, as the effects become nonsignificant and even unfavorable for the frequent questioner group. This is perhaps because users who frequently ask questions are more exploitation-based, so they may not be very attached to the community in general and, thus, are not very attracted to the gamified reward offered by the community.

Second, extant literature suggests that gamified rewards that can be attained multiple times may affect users differently than those that can be achieved only once (Bhattacharyya et al., 2020). Therefore, we examined the interaction between reward attainment specificity and repetition to

Table 7. Impact of Gamified Reward Specificity by User Preference

	<i>Answer24hrs_{it+1}</i>	<i>Question24hrs_{it+1}</i>
Panel A: Frequent Answerer Group (N=1,067,553)		
<i>Intercept</i>	-2.329*** (0.016)	-4.479*** (0.048)
<i>AnsSpec_{it}</i>	0.447*** (0.010)	-0.351*** (0.035)
<i>QuesSpec_{it}</i>	-0.569*** (0.014)	0.429*** (0.033)
<i>MultipleAward_{it}</i>	-0.867*** (0.012)	-0.946*** (0.031)
<i>Silver_{it}</i>	-0.150*** (0.010)	-0.306*** (0.032)
<i>Gold_{it}</i>	-0.061* (0.024)	-0.324*** (0.073)
<i>WeekDayUTC_{it}</i>	0.155*** (0.013)	0.201*** (0.038)
<i>BeginDayUTC_{it}</i>	0.064*** (0.012)	0.112*** (0.033)
Panel B: Frequent Questioner Group (N=1,514,861)		
<i>Intercept</i>	-2.299*** (0.025)	-3.220*** (0.026)
<i>AnsSpec_{it}</i>	0.015 ^{ns} (0.022)	-0.588*** (0.031)
<i>QuesSpec_{it}</i>	-1.206*** (0.020)	-0.080*** (0.018)
<i>MultipleAward_{it}</i>	-1.984*** (0.021)	-1.182*** (0.017)
<i>Silver_{it}</i>	-0.263*** (0.025)	-0.367*** (0.019)
<i>Gold_{it}</i>	0.030 ^{ns} (0.055)	-0.207*** (0.037)
<i>WeekDayUTC_{it}</i>	-0.059** (0.021)	0.140*** (0.021)
<i>BeginDayUTC_{it}</i>	-0.251*** (0.020)	0.105*** (0.017)

Note: ns = nonsignificant; **p*<0.1; ***p*<0.05; ****p*<0.01; standard errors are in parentheses.

see how they can jointly determine the contemporaneous knowledge contribution. As we report in Table 8, gamified reward repetition did not impact our observed effects of gamified reward specificity on contemporaneous knowledge-sharing. However, gamified reward repetition may change how gamified reward specificity can influence contemporaneous knowledge-seeking. Specifically, we found that attaining question-specific badges that can be awarded multiple times can significantly decrease users' contemporaneous knowledge-seeking while achieving answer-specific badges that can be awarded multiple times can dramatically increase users' contemporaneous knowledge-seeking. This phenomenon can be attributed to the diminishing effects of reward repetition, as reported by Bhattacharyya et al. (2020). When users do not place a high value on repeatable badges, it can decrease their motivation to contribute to activities

associated with them, which can shift their interest to other activities. Yet, future research should investigate this interesting finding further.

Table 8. Interaction Effects of Gamified Reward Specificity and Repetition (N=3,264,621)

	<i>Answer24hrs_{it+1}</i>	<i>Question24hrs_{it+1}</i>
<i>Intercept</i>	-2.445*** (0.010)	-3.319*** (0.014)
<i>AnsSpec_{it}</i>	0.385*** (0.010)	-0.985*** (0.022)
<i>QuesSpec_{it}</i>	-0.726*** (0.010)	0.368*** (0.012)
<i>MultipleAward_{it}</i>	-1.220*** (0.013)	-1.462*** (0.021)
<i>AnsSpec_{it} × MultipleAward_{it}</i>	0.632*** (0.015)	0.516*** (0.035)
<i>QuesSpec_{it} × MultipleAward_{it}</i>	-0.604*** (0.018)	-0.122*** (0.023)
<i>Silver_{it}</i>	-0.135*** (0.009)	-0.356*** (0.016)
<i>Gold_{it}</i>	0.097*** (0.021)	-0.302*** (0.032)
<i>WeekDayUTC_{it}</i>	0.055*** (0.008)	0.068*** (0.011)
<i>BeginDayUTC_{it}</i>	-0.031*** (0.008)	0.171*** (0.010)

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; standard errors are in parentheses.

Discussion and Concluding Remarks

Different categories of gamified rewards are often mashed up to encourage online users' knowledge contributions in Q&A communities. Yet, the differential effects of badge categories are seldom explored. To our knowledge, this study is one of the first to investigate how gamified reward specificity can motivate users' contemporaneous knowledge contribution.

Research Contributions

Our study makes a three-fold contribution to current research. First, beyond the dominant interests in the motivational effect of gamified rewards, our study complements the extant literature of online Q&A communities by providing empirical evidence to answer the research call for examining the differential effects of gamified reward categories via the notion of specificity (Cavusoglu et al., 2021). Our results suggest that compared to a general type of reward, awarding badges that directly incentivize a specific activity can significantly strengthen users' interest in repeating this incentivized activity but seriously undermine users' interest in performing the non-incentivized activity. Our findings offer first-hand evidence suggesting that not all gamified rewards are created equal and informing extant literature on both the positive and negative effects of gamified rewards on users' knowledge contributions.

Secondly, as a departure from prior studies of UGC in online communities, we proposed a viable approach to evaluating knowledge contributions based on two major activities in online Q&A communities. Existing Information Systems (IS) literature underscores the importance of examining immediate responses to stimuli (Fang et al., 2015) as it can reveal the motivational impact of virtual rewards or tech artifacts that lead users to act without extensive cognitive deliberation. To illustrate, users may have privacy concerns, inhibiting their voluntary contributions to the online community. Limited research addresses whether and to what degree gamified rewards can trigger impulsive and non-impulsive contributions to the online community. As our results suggest, the observed effects of gamified reward specificity can be a valid factor in explaining users' contemporaneous knowledge contributions. These findings shed new light on the contemporary literature by demonstrating that gamified rewards can simulate aggregated knowledge contributions that may be subject to cognitive and personal factors (i.e., knowledge self-efficacy and enjoyment in helping others) but can also stimulate spontaneous contributions that usually do not involve cognitive processing.

In addition to fruitful contributions to extending the contemporary literature, our study offers empirical support for regulatory fit theory in two ways. Foremost, we argue the relevance of regulatory fit theory by proposing the theoretical framework of gamified reward specificity and extending it to the context of online Q&A communities. Our empirical evidence supports this theoretical extension by confirming all of our hypotheses. In addition, although the theory emphasizes the importance of regulatory fit (specificity) in motivating individuals' future behaviors but offers less attention to the impacts of nonfit (non-specificity), our findings confirm the utility of regulatory fit theory in explicating the differential effects of gamified rewards. Specifically, we found that awarding a badge (e.g., answer- or question-specific badges) can also disrupt one's interest in performing subsequent activities and decrease voluntary knowledge contributions.

Practical Contributions

Our study offers insights for online Q&A community operators, developers, and managers when designing and implementing badge systems. First, our finding suggests that Q&A communities could implement a particular badge type to boost a specific kind of knowledge contribution quickly. This finding is important because using gamified rewards, such as badges, is generally considered more cost-effective than financial incentives to stimulate user engagement.

Second, since awarding users with gamified rewards can be a double-edged sword, Q&A communities should be mindful of the adverse spillover effects of badges on non-incentivized activities. For example, awarding answer-specific badges can significantly reduce users' interest in knowledge-seeking, and awarding question-specific badges can significantly undermine users' interest in knowledge-sharing. Thus, Q&A communities should consider an alternative or more balanced approach for providing different badges to incentivize different types of voluntary knowledge contributions. Community operators should adopt a diverse range of reward mechanisms instead of emphasizing a specific badge type (either for questions or answers). This promotes varied user engagements and avoids favoring one kind of knowledge contribution at the expense of another.

Concluding Remarks

To conclude, our study examines the differential impacts of badge categories on contemporaneous knowledge contribution by involving knowledge-seeking and knowledge-sharing. Drawing on regulatory fit theory, we propose a conceptual framework of gamified reward specificity to explain how badge attainments can increase or decrease users' contemporaneous knowledge contributions. This study is not without limitations that motivate future research. First, our study only considers three major badge attainment categories, thus limiting our findings to knowledge-sharing and knowledge-seeking. Future research should explore other badge categories (e.g., moderation badges) to better understand gamified reward specificity's effects comprehensively. Second, this study considers whether users make a specific kind of knowledge contribution activity after badge attainment but does not consider how often they are rewarded. For example, a user can be motivated to perform multiple activities within 24 hours after being awarded a badge. Future research can explore the frequencies of contemporaneous knowledge contribution by grouping the number of subsequent activities a user made within the 24-hour window or the next seven days after a badge is rewarded. Third, because our study examines the impacts of gamified reward specificity at the badge attainment level, our study did not consider the joint effects of user characteristics, such as tenure, reputation, etc. Future research should consider these user characteristics to fully understand gamified reward specificity on voluntary knowledge contributions. Fourth, our study examines user contributions made within 24 hours of awarding badges. Future research might benefit from investigating additional post-related aspects, including the quality of questions, the quantity of answers, and their respective ratings. Fifth, given the constraints in our dataset, badge awards were exclusively analyzed during weekdays and at the start of the day, as defined by UTC, due to the absence of data concerning users' real-time geolocations at the moment of badge attainments. Future research may benefit from factoring in users' local times, thereby facilitating a more nuanced understanding of the optimal timings to award badges that could motivate knowledge contributions. Lastly, our study primarily explored non-monetary gamified rewards. Thus, our findings can serve as a point of departure for future research to contrast gamified rewards with monetary incentives to better understand their distinct effects and possible intersections in shaping knowledge contributions within Q&A communities.

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Appendix A. Representative Studies Related to Our Study.

Study	Summary	Reward Attainment Specificity + Contemporaneous Knowledge Contribution/Seeking?
This study	Contemporaneous effects of gamified reward specificity on knowledge contribution.	✓
Research Stream 1: Internal Factors for Knowledge Contribution		
Khansa et al. (2015)	Habits (e.g., current and past behaviors) positively affect knowledge contributions for both knowledge sharing and seeking.	
Zhao et al. (2016)	Enjoyment in helping others and knowledge self-efficacy increase knowledge sharing.	
Wasko & Faraj (2005)	Reputation, enjoy helping, centrality, and commitment significantly affect knowledge contribution helpfulness, whereas reputation, centrality, tenure, and reciprocity affect knowledge contribution volume.	
Jin et al. (2013)	Reputation, reciprocity, enjoyment in helping others, knowledge self-efficacy, and satisfaction are key factors affecting a user’s continuance intention to share knowledge in Yahoo Answer.	
Bateman et al. (2011)	Three types of online community commitments (e.g., affective, normative, continuance) predict different community participation, such as reading threads, posting replies, and moderating discussions.	
Yu et al. (2011)	The egoistic motive is an important factor in mediating the effects of the perceived effectiveness of the knowledge repository and the perceived salience of social identity on knowledge contributions in a virtual community.	
Lou et al. (2013)	Enjoy helping, knowledge self-efficacy, and perceived learning in knowledge contributions are strong predictors for both knowledge contribution quantity and quality. In addition, virtual rewards (e.g., reputation) are positively associated with knowledge contribution quantity but not quality in Baidu Knows.	
Research Stream 2: Gamified Reward for User Contributions		
Chen et al. (2022)	Receiving external incentives, such as granted badges, gaining a reputation, and closeness to the next privilege, can motivate Stack Overflow users to contribute more answers; moreover, closeness to the next privilege has a curvilinear relationship with users’ subsequent knowledge contributions.	
Dong et al. (2020)	Status standing can moderate the effects of virtual reward, peer recognition, and opinion leadership on user contribution in Dianping.	
Bhattacharyya et al. (2020)	Receiving virtual recognition (e.g., “Yelp Elite Squad”) for the first time can increase user contribution, but	

	receiving virtual recognition multiple times will decrease user contribution.	
Wei et al. (2015)	Reputation and badge do not motivate knowledge contribution in Stack Exchange.	
Zhang et al. (2020)	Receiving a virtual title (e.g., “Yelp Elite Squad”) can increase review length, quantity, and rating, but decrease review quality measures, such as rating variance, readability, and ratio of one star in a short-term period (1 year). However, the effect of receiving a virtual title on user contribution can attenuate over time, in a long-term period (3 years).	
Burtch et al. (2022)	Receiving peer rewards (e.g., Reddit’s Gold Award) can significantly increase the volume of user contributions, such as post length and post volume. However, users who received peer rewards are more likely to post similar content to their past posts. In addition, the effects observed are prominent for new users rather than established members.	
Zimmerling et al. (2019)	In an idea generation contest, incentivizing users with virtual points and badges (e.g., posting comments or ideas) can motivate their contributions to effortless tasks, such as comments, but it does not increase the quality of ideas generated.	
Goes et al. (2016)	Incentive hierarchies of points (e.g., answerers earned points given by askers) have an unintended effect in which answerers increase their knowledge sharing before reaching a new level but reduce their knowledge sharing after reaching the new level.	
Cavusoglu et al. (2021)	Virtual badges can increase user knowledge sharing, and an earned gold badge is the most motivating for users to contribute their knowledge.	
Anderson et al. (2013)	Users tend to contribute more right before they receive a badge but contribute less after they receive a badge.	
Yanovsky et al. (2021)	Different types of users may respond to the steering effect of virtual badges differently.	

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