Effective Implementation of Feedback in Gamification

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Verifying the utility of feedback to induce behavior

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Abstract
In healthcare, promoting behavior change is important for improving health and supporting the treatment process. Gamification has gained attention as an effective means of achieving this aim. As motivation is important for promoting behavior change, it is key to ensure that participants are given opportunities in ways that make them feel in control. Therefore, this study investigated how to effectively implement "feedback," which is an element of gamification, as a means of providing these opportunities. The objective was to confirm whether desired behavior is promoted by allowing users to exercise choice and self-determination when receiving opportunities or chances to act. As part of this investigation, a lifelog app was distributed for measuring steps walked, and a randomized controlled trial was conducted to provide feedback to the users—None, Report-, Suggestion-, and Acceptance-type. Based on an analysis and evaluation of feedback utility from measuring the number of steps taken by the users according to the app's user log, the average numbers of steps for each feedback type during the entire measurement period were 8020.8, 8094.0, 8118.4, and 8453.1, respectively. Nonparametric tests showed statistical differences; hence, we used the Bonferroni correction for multiple comparisons. The results showed a statistically significant difference between the Acceptance group, which exercised choice and self-determination, and the None group. The study thus identified an effective feedback method for inducing desired behavior and argues that improving feedback utility contributes to successful gamification that encourages behavior change.

Keywords: gamification, feedback design, behavior change

1. Introduction

In healthcare, promoting behavior change is important for improving health and assisting treatment. Among various techniques for changing behavior, gamification has gained attention and is being pursued as a possibly effective method. Gamification is believed to have the potential to encourage proactive participation, raise motivation, and promote healthy behaviors by incorporating elements and approaches from games into other areas. However, there is still insufficient understanding of the theoretical mechanisms and the psychological basis of gamification [1][2][3].

In the healthcare field, there are multiple theories on how to promote behavior change. These include the COM-B model, the effects of which have already been confirmed [4][5]. In this model, the main elements of behavior change are "motivation," "ability," and "opportunity," which can be adjusted to promote behavior. Similarly, the Fogg Theory focuses on "motivation," "competence," and "chance" as influencing elements [6]. These theories indicate the importance of motivation in behavior change.

Self-Determination Theory is a widely accepted motivation theory [7]. Its critical concepts are "autonomy," "competence," and "relatedness." Of these, autonomy is the most emphasized—extrinsic motivation can be transformed into intrinsic motivation (internalization) by recognizing that one decides on one's own.

In recent years, the Nudge Theory has gained significant attention in the field of behavior change and is being actively adopted by public institutions [8][9]. A nudge represents encouraging behavior through indirect encouragement, instead of coercion. It is important for participants not to lose their sense of choice, but rather feel that they control things of their own volition.

Hence, providing gamification users with opportunities and chances for self-deterministic behavior, thus raising their motivation, is key to effectively promoting behavior change. Consequently, this study focuses on "feedback" as a technique for motivating behavior change and investigates its role and effective implementation methods.

Feedback, in the context of gamification, includes a wide range of elements, from providing information explaining usage and situations to increasing points and acquiring badges as one progresses through a game. This type of feedback visualizes progress in terms of small successes, enhances self-efficacy, improves persistence, and raises commitment to achieving future objectives [10][11]. However, if feedback is not properly implemented, its effects are not fully demonstrated, negatively affecting the users [12].

Therefore, this study explores methods of providing feedback and verifies their effectiveness in inducing desired behavior. Verification was accomplished by using text information-based feedback to raise reproducibility, followed by preparing multiple methods of providing feedback to change the degree of impact upon behavior. Furthermore, the study evaluates their effects on user behavior and measures changes in the latter per method.

The study checks whether desired behavior is promoted when users exercise choice and self-determination when receiving opportunities and chances to act. The aim is to identify effective feedback methods for inducing desired behavior, thereby improving feedback utility for successful gamification that encourages behavior change.

2. Literature Review

2.1 The COM-B Model

The COM-B model was developed by Susan Michie, Maartje van Stralen, and Robert West in 2011. Multiple frameworks for behavior change intervention already existed. Although several were rather successful, none had overwhelming effects. Thus, Michie et al. studied conventional approaches and fashioned the COM-B model based on the limitations of previous frameworks. The model is part of the behavior change wheel, which is the framework developed by Michie et al. [4].

The COM-B model is widely used to identify what needs to be changed for effective behavior change intervention. In this model, Capability (C), Opportunity (O), and Motivation (M) are the three critical elements that can alter Behavior (B) (Figure 1). Behavior is affected by several factors, and changing at least one of these elements causes a behavior change.

In the COM-B model, “C” refers to whether there is the necessary capability, skill, and knowledge to adopt a specific behavior. Physical capability refers to physical functions, such as physical strength, stamina, and physical skills. Psychological capability includes knowledge and mental skills, such as concentration, memory, and judgment ability.

“O” refers to the external factors that enable a specific behavior, that is, physical and social opportunity. Physical opportunity refers to the environment in which a behavior occurs, including economic conditions and physical resources, such as time. Social opportunity includes important interpersonal relationships and broader social network behavior.

“M” is an internal process that influences decision-making and behavior. Its two main elements are reflective (reflexive) motivation, which is the introspective process involved in planning, and automatic (emotional) motivation, which is the automatic process of impulses and inhibitions. Motivation is the core of the model and includes all internal processes that cause or inhibit behavior.

The elements of the COM-B model interact through positive and negative feedback loops to form a dynamic system. For example, if one is participating in a properly designed rehabilitation program, their physical capability will improve (they will feel the improvement). This will make them want to work harder at rehabilitation, which would then positively impact motivation. However, with insufficient facilities and equipment, and if people feel they cannot hope for continuous rehabilitation, motivation may decrease.

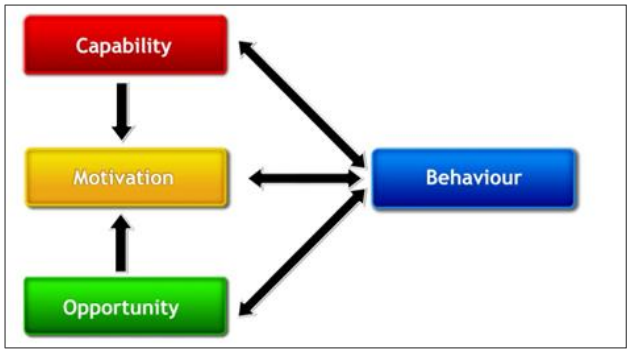

Figure 1 The COM-B System (Michie et al. 2011)

In behavior change, the Fogg Behavior Model, proposed by B. J. Fogg of Stanford University, is widely used [6][13]. The theory suggests that a person’s behavior is caused by three elements—Motivation (M), Ability (A), and Prompts (P)—and is expressed by an easy-to-understand formula: B = MAP (Figure 2).

The Fogg Behavior Model views behavior as a pure result and covers motivation and ability under chance. However, the relationships among elements in the COM-B model are bilateral and fluid. In this model, behavior is generated only when there is sufficient ability, motivation, and opportunity. Behavior is an index showing that a person has sufficient motivation and ability to do something and the opportunity to do it.

What is important in the COM-B model and the Fogg Behavior Model is that a person needs the ability and opportunity to behave in a certain way to gain the motivation to do so.

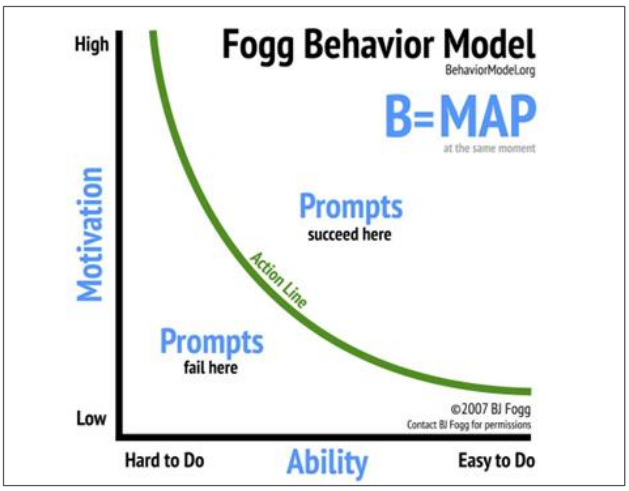

Figure 2 Fogg Behavior Model (Fogg 2007)

2.2 Self-Determination Theory

Research on Self-Determination Theory compares intrinsic and extrinsic motivation, increasing our understanding of the role of the former in individual behavior. Thereafter, the theory was advocated in *Intrinsic Motivation and Self-Determination in Human Behavior*, authored by psychologists Edward L. Deci and Richard Ryan in 1985.

Motivation consists of "intrinsic motivation," which springs forth from inside oneself, and "extrinsic motivation" to behave in a specific manner based on an external source. Intrinsic and extrinsic motivation are viewed as somewhat contradictory. However, in Self-Determination Theory, these motivations are positioned as a continuum and change depending on the degree of self-determination; that is, the theory considers motivation as a continuum from non-self-determination to self-determination.

Motivation changes from extrinsic to intrinsic depending on the degree of self-determination. Extrinsic motivation may be divided into four stages: external regulation, introjection, identification, and integration. Progress through the stages depends on how high the degree of self-determination is, eventually reaching intrinsic motivation (Figure 3). Internalization refers to proactive attempts to change extrinsic motivation into personal values, thereby internalizing external behavior regulation.

In Self-Determination Theory, satisfying autonomy, competence, and relatedness (the three elements of psychological needs) is important for causing behavior. These three needs are innate to humans and are not influenced by surrounding culture.

Autonomy is the feeling that one's behavior is voluntary and not coerced by others. Satisfying autonomy requires the feeling that one's behavior and objectives are under one's control. The feeling of being able to take direct action and bring about change plays a major role in influencing one's self-determination.

Competence is the feeling that one possesses an ability and is useful to society. When a person feels that they possess the necessary skills to achieve something on their own, they are more likely to take action and achieve objectives. Thus, there is a need to deepen the understanding of tasks and acquire various skills.

Relatedness is the need to build respectful spiritual relationships with others. A sense of belonging and attachment are important concepts that influence an individual's psychological health and social stability.

Among the three, autonomy is considered the most important need. The stronger the feeling of "I decided my own behavior," the more psychologically satisfied one feels. Therefore, when extrinsic motivation becomes stronger due to rewards and penalties, people begin to feel that they can no longer control their behavior, which can lead to a loss of autonomy and decrease intrinsic motivation [14][15].

However, positive feedback can increase the feelings of self-determination. Providing positive encouragement and feedback about job performance can increase intrinsic motivation. This type of feedback is useful for a greater feeling of competence and a critical need for personal growth [7].

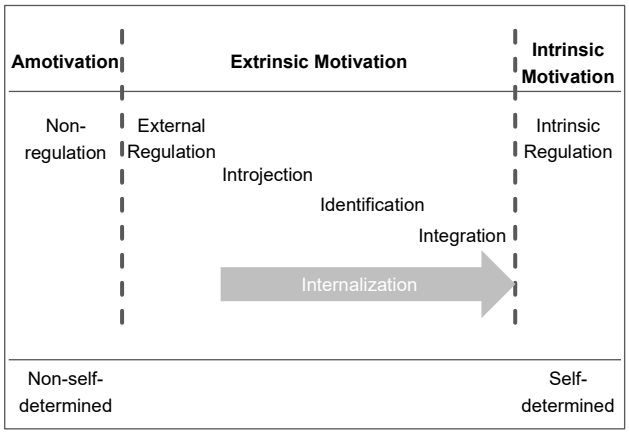

Figure 3 Self-Determination Theory: Taxonomy of Motivation
Note: Created by authors using Deci & Ryan 2021

2.3 Nudge Theory

In recent years, Nudge Theory has gained attention as a new approach to influencing behavior change. This concept was proposed by Richard H. Thaler and Cass R. Sunstein in their 2008 work, *Nudge: Improving Decisions about Health, Wealth, and Happiness* [16]. They constructed several theories based on the heuristic research of Daniel Kahneman and Amos Tversky [17].

Nudge Theory has been adopted into public policy and engendered responses in various countries [18][19]. In Japan,

both the Ministry of Health, Labour and Welfare and the Ministry of Economy, Trade and Industry have proceeded to utilize nudging to promote health and decarbonization [20][21]. In healthcare, its use is progressing in public health and clinical settings to support decision-making by medical professionals [22][23].

A nudge signifies a choice architecture that changes people's behavior in predictable ways without significantly changing economic incentives or prohibiting certain behaviors. In a nudge, obligation is not central to behavior; rather, decision-making is a more viable option. Nudge Theory aims to improve the understanding and management of the heuristic influences upon human behavior that are central to changing people. Accordingly, the use of Nudge Theory is based upon indirect encouragement and realization, instead of direct instruction and coercion.

Thaler and Sunstein describe heuristics as being equal to nudges. Heuristics refers to the tendency of people to think instinctively, emotionally, and subjectively during decision-making rather than logically, rationally, and objectively. They assume that heuristics are the fundamental propulsion of decision-making and offer several heuristic tendencies related to nudging.

Feedback is a major sophisticated element of heuristics. Responses during the thinking and decision-making process help one understand their situation, thoughts, and decisions. It can be given during thinking or after decision-making to adjust strategy and benefit from an experience. It is an important element for optimizing the efficacy of the Nudge Theory. However, feedback in this context is not the traditional one-to-one feedback; rather, it is primarily a process experienced by a large group of users or a part of system design, such as displays and signs.

The concept of Stimulus-Response Compatibility, which is heuristic, is the design of signs and language to ensure that messages are conveyed appropriately. This refers to how faithfully the "look and feel" (signs and signals) reflect and express the meaning of choice. In general, red connotes danger or caution, while green connotes safety, even if the words are different. Several examples can be given on thousands of recognizable patterns, habits, and symbols that can be found in everyday life. In addition, such symbols have increased in the digital age—an exclamation mark [!] meaning an important message, three lines indicating a menu, and a gear indicating settings.

Various nudge techniques, based upon heuristic tendencies, have been proposed; however, the default setting is one of the most frequently referenced nudges. A default is an initial value or setting determined to be effective when nothing has been set. This nudge, which acts on the human tendency to take no action, is particularly effective because it can stick around for years due to inertia [24][25]. Inertia is associated with the use of defaults in websites and forms that people encounter daily and is deeply embedded in the way options are displayed.

For a nudge to be effective, choice architecture, serving as a context for people to make decisions, needs to be created or modified so that individuals may easily make better choices [26]. For example, if before going to sleep one turns off their cell phone and puts it away in a drawer, then the possibility of picking it up first thing in the morning is smaller. Since it is not possible to pick up right away, one can resist the temptation more easily than if one sleeps with the smartphone next to the pillow. Similarly, a supermarket will place products that it wants to sell at the eye line of customers to catch their attention. Hence, by modifying or eliminating options, it is possible to induce people to make better decisions.

Nudge Theory is based on the idea that by shaping the environment, known as choice architecture, it is possible to influence the likelihood that individuals will choose specific options over others. In addition, it is important that individuals feel they retain the freedom of choice and control their decision-making.

3. Methodology

3.1 Study Overview

As part of this study, smartphone users in Japan were provided with a lifelog app. A randomized controlled trial was conducted by dividing them into four groups receiving different feedback. These four groups were as follows:

- No feedback (N)
- Report-type (R)
- Suggestion-type (S)
- Acceptance-type (A)

The lifelog app was distributed in Japanese via the App Store for iOS and Google Play for Android. Testing was conducted for four weeks (from November 17 to December 14, 2023) on logs acquired from 861 persons who used the app during this period (Table 1).

Table 1 Demographics of the four groups

(person)	N	R	S	A	%
Age					
-19		1			0.1
20-	6	7	6	3	2.6
30-	21	22	21	17	9.4
40-	33	33	34	42	16.5
50-	78	47	57	67	28.9
60-	92	92	83	99	42.5
Sex					
Male	166	153	148	166	73.5

Female	57	43	50	55	23.8
Not selected	7	6	3	7	2.7
ALL	230	202	201	228	
%	26.7	23.5	23.3	26.5	100

Walking was the subject of behavior change in this study. As age, sex, and region were irrelevant, these were left unrestricted. In addition, lifelog app users agreed to data collection and usage in the app's terms of use and privacy policy before starting usage.

3.2 Lifelog App

3.2.1 Usage Overview

Users were provided with a smartphone app that would supply their activity information, such as location. Participants would enter the following user information at the start of usage.

- Account information
  - Set ID and password to safely supply individual activity information.
- Nickname
  - Enter a nickname to maintain anonymity.
- Height, weight, date of birth, and sex
  - Entries required for activity information analysis. Date of birth is entered to verify age. Users could choose not to answer the question regarding their sex.

In addition, users earned 1 point reward for every 400 steps. Points were automatically calculated according to the number of steps. The acquired points could be used for game content available via a shared account.

The app did not require any special operation. Users would set the location information acquisition setting to "Always Allow," and the activity information would be automatically recorded during device use.

If the acquisition of location information was set to "Allow only during app use," activity would be recorded only as such. If the acquisition of location information was not allowed, the activity would not be recorded.

3.2.2 Functions

The lifelog app consists of Home, Record, Point, and My Page screens.

The home screen displays the number of steps, calories burned, activity time, and distance (Figure 4). This is the default screen when the app starts.

The Record screen displays an activity record (Figure 5). A map, the date, calories burned, time, distance, and activity are displayed daily. The day's travel route can be seen on the map. Activity units are displayed separately when a user is moving and is stationary, and travel is displayed using transportation, such as walking, car, or train.

The point screen displays the daily and monthly points earned and usage history (Figure 6). The points earned for earlier months can be browsed in the archives.

The My Page screen displays a weekly record, best record, and personal settings (Figure 7). The weekly record shows the activity registered for the current week on a graph. The best record displays the number of steps, calories burned, distance traveled, and travel times from the start of use to the present day.

Figure 4 Home

Figure 5 Record

Figure 6 Point

Figure 7 My Page

Personal settings allow users to edit account information and set the target number of steps per day, which may be set in 1,000 step units from 4,000 to 10,000 steps.

3.3 Types of Feedback

Four types of feedback were provided in this study: No feedback, Report-type, Suggestion-type, and Acceptance-type.

Effective feedback has three elements: feed up (goal confirmation), feed back (results or performances report), and feed forward (next steps presentation/suggestion). However, feedback does not always start with goal confirmation when the goal is specifically identified. In addition, while most feedback is generally task-related, it is most often accepted and understood when connected to the next objective, and least effective when it is praise or self-feedback [27].

Therefore, No feedback (N), Report-type (R), and Suggestion-type (S) feedback types were set up, corresponding to the concepts of feed up, feed back, and feed forward, respectively. In the case of this application, the number of steps per day was the simple goal and a major premise for its use. As the user understood the goal with or without confirmation, the confirmation was not the reason the goal became clear. Hence, this situation was defined as No feedback (N) because it was considered to be almost ineffective as a feed up. Then, the Acceptance-type (A), which added an element of self-determination to the suggestion-type (S), was included to complete the four types.

These feedback types were provided on the home screen when the app was launched and when it was displayed in the foreground. Since the home screen was the default screen, feedback was provided without the need for any action once the user displayed the app.

The implementation of each feedback type is as follows.

- No feedback (N)
  - Only the present number of steps and the goal number of steps were displayed (Figure 8).
- Report-type (R)
  - The points gained were explicitly displayed as feedback (Figure 9).
- Suggestion-type (S)
  - The text was explicitly displayed as a hint of the next objective (Figure 10). For example, it displayed the number of steps needed from the present number to earn the points displayed.
- Acceptance-type (A)
  - The text was explicitly displayed as a hint of the next objective, with a dialog box to respond to the suggestion (Figure 11). Buttons were installed for “Try hard” and “Give up” in the dialog box, and it was specified that the box could be closed by choosing either option when a hint was presented.

Figure 8 No feedback (N)

Figure 9 Report-type feedback (R)

Figure 10 Suggestion-type feedback (S)

Figure 11 Acceptance-type feedback (A)

3.4 Analytical Method

The number of steps was used as an index for measurement and analysis. The number of steps per group over a period was calculated, and after a nonparametric (Kruskal-Wallis) test, multiple comparisons (Bonferroni correction and Steel-Dwass test) were performed.

As the number of steps greatly differed on the first day, depending on the moment the app was downloaded (i.e., morning or night), logs were aggregated only from the second day of use to the last day of the measurement period. In addition, daily logs with less than 1,000 or more than 30,000 steps were not aggregated, as an exceptional day in either scenario did not qualify for general services. A smartphone function may have a large step count due to unintentional shaking of the device, therefore, steps over 30,000 were excluded as abnormal values. Based on the results, 8,238 out of 10,292 logs were collected as samples.

4. Results

4.1 Average Number of Steps (Entire Period)

Figure 12 shows the results of the average number of steps by group for the entire period. N had 8020.8 steps, R had 8094.0 steps, S had 8118.4 steps, and A had 8453.1 steps. The group median was 6743.0, 7095.0, 7085.5, and 8081.0 steps, respectively. The graph indicates that A has the highest distribution compared to the other groups.

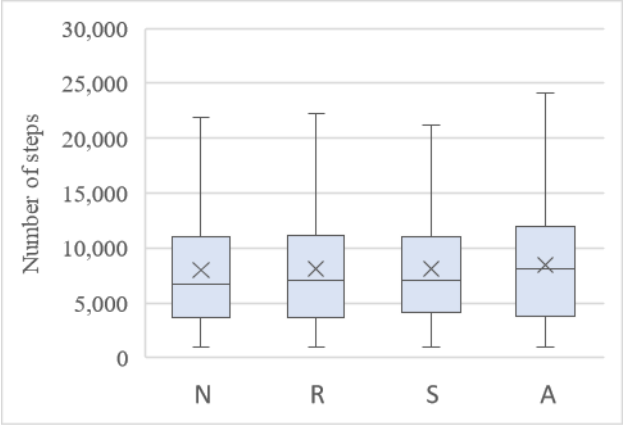

Figure 12 Average number of steps per group

4.2 Multiple Comparisons of Average Number of Steps

The results of the Kruskal-Wallis test for the number of steps in each group showed a significant difference under the significance level of 0.05 ($\chi 2 = 9.7873$, $p = 0.0205$). The results of the Bonferroni correction for multiple comparisons are presented in Table 2. Since the p-value of N vs. A is 0.023, their results are significant at 0.05.

Table 2 Results of multiple-comparison Bonferroni correction

	A	N	R
N	0.023*	-	-
R	0.208	1.000	-
S	0.247	1.000	1.000

*p < .05

Furthermore, multiple comparisons through the Steel-Dwass test revealed a significant difference between N vs. A at a significance level of 0.05, similar to the Bonferroni correction (Table 3). However, it showed no significant difference for the other combinations.

Table 3 Results of multiple-comparison Steel-Dwass test

	t	p
A:N	2.8950929	0.0198244*
A:R	2.1126843	0.1489892
A:S	2.0426166	0.1724265

N:R	0.8523366	0.8292794
N:S	1.2964762	0.5651521
R:S	0.3259883	0.9880415

* p<.05

5. Discussion

Based on the results of the multiple comparisons, a significant difference was confirmed between N and A. However, since acceptance can be expressed in various ways, further improvements may be possible.

In the app provided in this study, the display of an A dialog box was devised. When a user started the app, it was considered to be done to check the present number of steps and points earned. If the dialog box suddenly appeared and hid the desired information, there would be an urge to close the dialog box without checking its contents.

Therefore, the A dialog box appeared at the bottom of the screen so that the main information was not hidden (Figure 11). Furthermore, the dialog box was deliberately displayed with a delay of one second after startup. User reactions may change due to such UI improvements, and differences in reactions will eventually lead to behavior changes.

Although there is room for discussion regarding the methods used for obtaining users' acceptance, such as the time of obtaining it and the number of options presented, the context of self-determination must be considered. For example, while the app sets a target number of steps in advance, feedback can also be provided in the form of a question asking what kind of behavior the user wants to choose, based on their progress toward the goals. In this case, the context becomes more complicated, such as a prerequisite need arising for the user to set an appropriate objective; however, it may be necessary to choose an appropriate context in education or training where users need to be evaluated in terms of absolute values.

In addition, no significance with N could be confirmed for R and S. However, the influence upon behavior varies with the different types of feedback. These differences may become clearer with a large-scale detailed analysis over a longer period.

6. Conclusion

This study conducted an experiment focusing on providing opportunities and chances as elements for inducing behavior. Based on the results using different types of feedback methods, it was confirmed that when receiving feedback, a positive impact on behavior can be gained if users receive it in a self-determined manner that involves choice and corresponding acceptance.

Providing feedback contributes to improving user motivation. However, to maximize its utility, the feedback method must be focused on inducing the desired behavior for successful gamification. The findings support the achievement of desired results by contributing to the implementation of effective feedback in practical gamification.

In general, the purpose of feedback is to reduce the gap between present status and goals. Although encouraging behavior is highly important, ascertaining absolute or relative progress and results is meaningful for choosing a strategy. Feedback on the success or failure of past actions can prevent future failures and improve behavior quality. Furthermore, in gamification, creating enjoyment through instant feedback cannot be overlooked.

It is important to use feedback techniques appropriately in various gamification scenarios. In particular, it is essential to induce desired behavior, geared toward successful gamification, through self-determination. The empirical results revealed in this study also provide suggestions for visual representations of feedback.

6.1 Study Limitations

This experiment used text information to improve reproducibility; however, the wording of A group's responses was nuanced. Thus, the results may have differed if the wording were changed.

In addition, both the COM-B model and Fogg Behavior Model list performance ability as an element. This experiment did not consider this point because it targeted behavior with relatively few constraints. However, it is assumed that feedback may be received at times when it is impossible to walk due to environmental factors. Feedback effectiveness can be measured more precisely by assessing performance while ensuring performance ability.

6.2 Future Research

In addition to how feedback is provided, its implementation has both UX-type elements, such as context and timing, and UI-type elements, such as visual design and display position. An overall appropriate implementation is required within the design of a feedback system for gamification. As there is ample room for investigation, we would like to expand our scope of research to these areas.

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References

[1] Damaševičius, R., Maskeliūnas, R. & Blažauskas, T., *Serious Games and Gamification in Healthcare: A Meta-Review*, Information, Vol. 14, No. 2, p. 105, 2023.

[2] Koivisto, J. & Hamari, J., *The Rise of Motivational Information Systems: A Review of Gamification Research*, International Journal of Information Management, Vol. 45, pp. 191–210, 2019.

[3] Krath, J., Schürmann, L. & von Korflesch, H. F. O., *Revealing the Theoretical Basis of Gamification: A Systematic Review and Analysis of Theory in Research on Gamification, Serious Games and Game-Based Learning*, Computers in Human Behavior, Vol. 125, p. 106963, 2021.

[4] Michie, S., Atkins, L. & West, R., *The Behaviour Change Wheel: A Guide to Designing Interventions*, Silverback Publishing, 2014.

[5] National Institute for Health and Care Excellence, *Behaviour Change: Individual Approaches*, 2014. https://www.nice.org.uk/guidance/ph49/resources/behaviour-change-individual-approaches-pdf-1996366337989

[6] Fogg, B. J., *A Behavior Model for Persuasive Design,* In Proceedings of the 4th International Conference on Persuasive Technology 1–7, Association for Computing Machinery, 2009.

[7] Deci, E. L. & Ryan, R. M., *Intrinsic Motivation and Self-Determination in Human Behavior*, Springer US, 1985.

[8] OECD, *Behavioural Insights in Public Policy: Key Messages and Summary from OECD International Events,* May 2017. https://web-archive.oecd.org/2017-06-13/442460-OECD-events-behavioural-insights-summary-may-2017.pdf.

[9] Behavioral Sciences Team, *About the Nudge Unit of Japan (BEST: Behavioral Sciences Team)*, Ministry of the Environment. https://www.env.go.jp/earth/best.html.

[10] Burgess, A., van Diggele, C., Roberts, C. & Mellis, C., *Feedback in the Clinical Setting*, BMC Medical Education, Vol. 20, No. 2, p. 460, 2020.

[11] Schoch, M., Berger, M., Lahmer, S. & Reuther, M., *Preferred Gamification Elements in a Health Behavior Change Support System for Stress Management*, In Proceedings of the 56th Hawaii International Conference on System Sciences (ed. Bui, T. X.), pp. 2973–2982, ScholarSpace, 2023.

[12] Kluger, A. N. & DeNisi, A., *The Effects of Feedback Interventions on Performance: A Historical Review, A Meta-Analysis, and A Preliminary Feedback Intervention Theory*, Psychological Bulletin, Vol. 119, No. 2, pp. 254–284, 1996.

[13] Fogg, B. J., *Fogg Behavior Model*, 2020. https://behaviormodel.org/.

[14] Rode, J., Gómez-Baggethun, E. & Krause, T., *Motivation Crowding by Economic Incentives in Conservation Policy: A Review of the Empirical Evidence*, Ecological Economics, Vol. 117, pp. 270–282, 2015.

[15] Deci, E. L., Olafsen, A. H. & Ryan, R. M., *Self-Determination Theory in Work Organizations: The State of A Science*, Annual Review of Organizational Psychology and Organizational Behavior, Vol. 4, pp. 19–43, 2017.

[16] Thaler, R. H. & Sunstein, C. R., *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Yale University Press, 2008.

[17] Tversky, A. & Kahneman, D., *Judgment Under Uncertainty: Heuristics and Biases*, Science, Vol. 185, No. 4157, pp. 1124–1131, 1974.

[18] Halpern, D. & Sanders, M. *Nudging by Government: Progress, Impact, & Lessons Learned*, Behavioral Science & Policy, Vol. 2, No. 2, pp. 53–65, 2016.

[19] Goyens, M. et al. *Nudging in Public Policy: Application, Opportunities and Challenges*, Intereconomics, Vol. 53, No. 1, p. 4, 2018.

[20] Ministry of Health, Labour & Welfare, *Handbook of Measures to Improve Examination Rates (2nd ed.)*, 2019. https://www.mhlw.go.jp/stf/newpage_04373.html.

[21] Agency for Natural Resources and Energy, *Sixth Strategic Energy Plan*, 2021 https://www.enecho.meti.go.jp/category/others/basic_plan/.

[22] Yoong, S. L. et al., *Nudge Strategies to Improve Healthcare Providers' Implementation of Evidence-Based Guidelines, Policies and Practices: A Systematic Review of Trials Included Within Cochrane Systematic Reviews*, Implementation Science, Vol. 15, No. 50, 2020.

[23] Wolf, A., Sant'Anna, A. & Vilhelmsson, A., *Using Nudges to Promote Clinical Decision Making of Healthcare Professionals: A Scoping Review*, Preventive Medicine, Vol. 164, p. 107320, 2022.

[24] Hummel, D. & Maedche, A., *How Effective is Nudging? A Quantitative Review on the Effect Sizes and Limits of Empirical Nudging Studies*, Journal of Behavioral and Experimental Economics, Vol. 80, pp. 47–58, 2019.

[25] Last, B. S., Buttenheim, A. M., Timon, C. E., Mitra, N. & Beidas, R. S., *Systematic Review of Clinician-Directed Nudges in Healthcare Contexts*, BMJ Open, Vol. 11, No. 7, p. e048801, 2021.

[26] Goldstein, D. G., Johnson, E. J., Herrmann, A. & Heitmann, M., *Nudge Your Customers Toward Better Choices*, Harvard Business Review, Vol. 86, No. 12, pp. 99–105, 2008.

[27] Hattie, J. & Timperley, H., *The Power of Feedback*, Review of Educational Research, Vol. 77, No. 1, pp. 81–112, 2007.